

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

MOTIF FOODWORKS, INC.,

Petitioner,

v.

IMPOSSIBLE FOODS INC.,
Patent Owner.

U.S. Patent No. 10,039,306

“METHODS AND COMPOSITIONS FOR CONSUMABLES”

Inter Partes Review No. 2023-00209

**DECLARATION OF DR. RODRIGO TARTÉ
IN SUPPORT OF PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 10,039,306**

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I, Rodrigo Tarté, Ph.D., declare as follows:

I. PROFESSIONAL BACKGROUND

1. I have been retained by Quinn Emanuel Urquhart & Sullivan LLP on behalf of Motif FoodWorks, Inc. (“Petitioner” or “Motif”) as an independent expert in this inter partes review (“IPR”) proceeding which is pending before the Patent Trial and Appeal Board (“the Board”) of the United States Patent and Trademark Office (the “Proceeding”). I understand that, in this Proceeding, Motif is challenging the validity of claims 1, 3–11, 13–14, 16–24, 26–27, and 29–33 (the “Challenged Claims”) of U.S. Patent No. 10,039,306 (the “’306 patent”). Based on the first page of the ’306 patent, I understand it to be assigned to Impossible Foods Inc. (“Patent Owner”).

2. I have been asked by Motif to provide my opinions regarding the validity of the ’306 patent claims in this declaration (“Declaration”).

3. I am informed that the ’306 patent has been asserted by Patent Owner against Motif in the co-pending litigation Impossible Foods Inc. v. Motif FoodWorks, Inc., Case No. 22-cv-311 (D. Del.) (“Litigation”). I understand that the Litigation is proceeding in the District Court for the District of Delaware (“District Court”).

4. I understand that, in the Litigation, neither party has exchanged any contentions relating to infringement (or non-infringement) or invalidity (or validity),

and that neither party has yet proposed any claim constructions. I further understand that the District Court has not been yet asked to construe any claims of the '306 patent and that no claim construction order has been issued. I also understand that Patent Owner has not filed any motions seeking injunctive relief and the District Court likely will not order claim construction briefing or a hearing until a later point in the Litigation. Lastly, I understand that the '306 patent has not been previously asserted in any litigation nor subject to any prior post-grant proceeding to review its validity against the prior art. I reserve the right to amend or supplement my opinions in this Declaration in response to any positions that Patent Owner or its experts may take in the Litigation, or in response to any order of the District Court.

II. QUALIFICATIONS

5. Exhibit 1004 accompanying this Declaration is a true and correct copy of my current CV. It describes in greater detail my education, publications, employment and research history, and professional activities and awards.

6. I received a Bachelor's degree in Food Science and Technology in 1987, a Master's degree in Food Science and Technology in 1990, and a Ph.D. in 1996 in Food Science & Technology and Meat Science, all from Iowa State University.

7. I am presently an Associate Professor of Meat Science and Technology, in the Department of Animal Science at Iowa State University, USA. At Iowa State,

I teach courses in “Foods of Animal Origin,” “Science and Technology of Value-Added Meat Products,” and “Advanced Meat Processing,” and serve as Director of the Online Graduate Certificate in Meat Science program.

8. I joined the Iowa State faculty in 2015 after nineteen years in the meat processing industry, during which I held key research & development posts in major meat and food processing companies, primarily Kraft Foods/Oscar Mayer and John Morrell Food Group (a division of Smithfield Foods).

9. I have contributed numerous research articles, and several book chapters and trade articles relating to food science and meat processing, including oil structuring for animal fat replacement and fatty acid profile modification. *See, e.g., Kibler et al., Novel biphasic gels can mimic and replace animal fat in fully-cooked coarse-ground sausage*, 194 Meat Sci. 108984 (2022); *Tarté et al., High-oleic and conventional soybean oil oleogels structured with rice bran wax as alternatives to pork fat in mechanically separated chicken-based bologna sausage*, 131 LWT – Food Sci. & Tech. 109659 (2020); *Wolfer et al., Replacement of pork fat in frankfurter-type sausages by soybean oil oleogels structured with rice bran wax*, 145 Meat Sci. 352-362 (2018); *see also Tarté, Leveraging meat flavor understanding for product success*, 5(3):7 Meat Musc Biol. 1–6 (2022); *Ruther et al., Effects of processing method and non-meat binding ingredients on batter stability, yield and texture of frankfurters*, 44 J. Food Process Preserv. 14626 (2020);

Lee, Tarté, et al., *Synergistic effects of starch nanoparticles and chitin nanofibers on the stability of oil-in-water Pickering emulsions*, 363 Food Chem. 130301 (2021).

10. Among my honors, I have served as President of Phi Tau Sigma, The Honor Society of Food Science and Technology, past Chair of the Institute of Food Technologists (IFT) Muscle Foods Division and Board Member of the American Meat Science Association. In recognition of my longtime work and contributions in this industry, I have been awarded the Meat Processing Award from the American Meat Science Association.

11. I am a regular invited speaker at national and international conferences, symposia, workshops and webinars, and have presented my work at national and international meetings and conferences, such as the Reciprocal Meat Conference of the American Meat Science Association, the American Oil Chemists' Society Annual Meeting, the International Congress of Meat Science and Technology, and the Institute of Food Technologists Annual Meeting.

12. My primary areas of expertise and research are meat further processing, meat product formulation, non-meat ingredient technology and food safety microbiology. During the course of my work at Kraft Foods and Oscar Mayer, I worked on a variety of meat products in support of the Oscar Mayer, Louis Rich, and Lunchables brands. I also led a team of researchers in developing new food

technologies to enable the development of new products, improve utilization of raw materials, and cost, formula, and process improvements.

13. In the course of my work at Kraft Foods, I also worked on the development and improvement of meat substitute products. As an example of my work on meat substitutes: in 2000, Kraft purchased Boca Burger, Inc., a manufacturer and marketer of soy-based meat alternative products. I personally worked on the development and improvement of the texture, appearance, flavor, and meat-like characteristics of various Boca brand products. These products included burger and chicken analog products (patties and nuggets).

III. SUMMARY OF ASSIGNMENT

14. In forming my opinions regarding the validity of the '306 patent, I have considered the '306 patent's specification, including the Abstract and the figures. I have also considered the language of the patent's claims, as those terms would have been understood by a person having ordinary skill in the relevant field at least at the time of the '306 patent's earliest possible priority date. I have also reviewed the prosecution (the "file history") of the '306 patent.

15. In forming my opinions, I have also considered the Exhibits that are listed in the Petition and any additional materials and information cited in this Declaration. I have also searched for and reviewed technical literature relevant to the field of the '306 patent.

16. I have also relied on my personal knowledge, education, training, and professional experience in order to form my opinions concerning the '306 patent, including my experience in researching, studying, developing, or using meat substitutes and meat replica technology.

17. This Declaration explains, based on facts and information currently available to me, the subject matter and opinions related to this Proceeding. As such, I am prepared to provide expert testimony regarding opinions formed resulting from my analysis of the issues and materials considered in this Declaration, if asked to do so by the Board or by the parties' attorneys.

18. Additionally, I may discuss my own work, teachings, and knowledge of the state of the art in the relevant time period. I may rely on handbooks, textbooks, technical literature, and the like to demonstrate the state of the art in the relevant period and the evolution of relevant technologies.

19. Furthermore, I reserve the right to consider and respond to any arguments or technical literature that Patent Owner or its counsel may identify or assert in this Proceeding. I reserve the right to amend or supplement the opinions set forth in this Declaration as additional information becomes available to me and/or in response to positions asserted by Patent Owner or its experts.

20. Throughout this Declaration, I refer to specific pages of the '306 patent and other documents. These citations are intended to be exemplary and are not

intended to convey that the citations are the only source of evidence to support the propositions for which they are cited.

21. I am being compensated for my time preparing this declaration for this matter at a rate of \$300 per hour. My compensation is in no way contingent upon the outcome of this matter or on the opinions I offer. All of the opinions expressed in this Declaration are my own.

IV. LEGAL PRINCIPLES

22. In this section I describe my understanding of certain legal principles that I have relied upon in forming my opinions set forth in this Declaration.

23. I have been informed of these legal standards by counsel for Motif. I am not an attorney and I have not researched the law on patent invalidity. I am relying only on Motif's attorneys relating to these legal standards.

A. Person of Ordinary Skill in the Art

24. I am informed that patent validity is determined from the perspective of a person of ordinary skill in the pertinent art at the time of the invention ("POSITA"). I understand that a POSITA is a hypothetical person who is presumed to be aware of all pertinent art, conventional wisdom in the art, and is a person of ordinary creativity—not an automaton.

25. In deciding the level of ordinary skill in the art, I am informed that the following factors may be considered:

- the levels of education and experience of persons working in the field;
- the types of problems encountered in the field;
- the sophistication of the technology.

B. Claim Construction

26. I am informed that a patent may include two types of claims, independent claims and dependent claims. An independent claim stands alone and includes only the limitations it recites. A dependent claim can depend from an independent claim or another dependent claim. I am informed that a dependent claim includes all the limitations that it recites, in addition to the limitations recited in the claim from which it depends.

27. I understand that patent claim terms can be interpreted, or “construed.” I understand that, in construing a claim, the words of a patent claim are given their plain meaning, as a POSITA would understand them at the time of the invention, in view of the patent and file history (which I understand is considered “intrinsic” evidence), unless their meaning is defined or disclaimed. I am informed that dictionaries, treatises, and other “extrinsic” sources of evidence may assist in determining the plain meaning of a term, but they cannot override a meaning that is otherwise unambiguous based on the intrinsic evidence.

28. I understand that in construing claims in an IPR proceeding, words in a claim are given their plain meaning, which is the meaning understood by a person

of ordinary skill in the art in view of the patent and file history, unless specifically defined in the patent or prosecution history. I also understand that dictionaries or other extrinsic sources may assist in determining the plain and ordinary meaning but cannot override a meaning that is unambiguous from the intrinsic evidence.

29. I have been informed by Motif's counsel that claim construction is a matter of law for the arbiter of law to decide. I am informed that, in an *inter partes* review, the Patent Trial and Appeal Board interprets claims in the same way as a district court would. Likewise, I understand that a POSITA interprets claims in the same way in both types of proceedings.

30. I reserve my right to amend or alter my analysis and opinions in view of any claim constructions adopted by the arbiter of law.

C. Analogous Art

31. I am informed and understand that the scope of the prior art to a patent includes all analogous art. I am informed and understand that two separate tests define the scope of analogous prior art: (1) whether the art is from the same field of endeavor, regardless of the problem addressed and, (2) if the reference is not within the field of the inventor's endeavor, whether the reference still is reasonably pertinent to the particular problem with which the inventor is involved.

D. Obviousness

32. I am informed and understand that, under 35 U.S.C. § 103, a patent claim is invalid if the subject matter of the claim as a whole would have been obvious to a person of ordinary skill in the art at the time of the invention. I further understand that the following factors must be evaluated to determine whether the claimed subject matter is obvious: (1) the scope and content of the prior art; (2) the difference or differences between each claim of the patent and the prior art; (3) the level of ordinary skill in the art at the time the patent was filed; and (4) any objective indicia of non-obviousness, also known as “secondary considerations.” Such objective indicia include: long-felt but unresolved needs; commercial success; failure of others to solve the problem that the inventor solved; and surprising/unexpected results.

33. I am informed and understand that an obviousness determination generally requires a finding that all claimed limitations are disclosed in the prior art, and that a person of ordinary skill in the art would have been motivated to combine or modify the teachings in the prior art and would have had a reasonable expectation of success in doing so. I am further informed and understand that absolute predictability of success is not required, only a reasonable expectation.

V. PERSON OF ORDINARY SKILL IN THE ART

34. The '306 patent is directed to the art of food science and recombinant protein expression arts. In my opinion, a POSITA of the '306 patent would have a Bachelor of Science degree in food sciences, biology, chemistry, microbiology, or a related discipline. A POSITA would also have a Master's degree or Ph.D. in food science or at least three years of experience working as a food scientist.

35. As explained above I exceed all of these requirements. My opinions expressed herein are from the perspective of a POSITA.

36. For purposes of my analyses herein, I assume that the POSITA was working in the field before January 11, 2013.

VI. '306 PATENT OVERVIEW

A. Claims

37. The '306 patent contains 33 claims, of which claims 1, 14, and 27 are independent and the remainder dependent. I understand that the dependent claims contain all the elements of their respective independent claim in addition to the elements recited in the dependent claims.

38. The dependent claims are generally directed to methods with specific heme-containing proteins (claims 2-4, 15-17, 28-30), specific plant proteins (claims 9-10, 21-22, 32), narrower ranges of heme or plant protein concentrations (claims 5, 11, 18, 23, 31), purifying and isolating proteins (claims 6-8, 19-20, 24), solubility

of plant protein (claim 12, 25), and using the meat replica matrix in specific consumable products (claim 13, 26, 33).

B. Specification

39. Recognizing the “profound negative impact” of animal farming and meat consumption, the ’306 patent relates to “the production of non-meat consumable products” and various techniques therefor. EX1001, Abstract, 1:33–50.

40. Of relevance to the Challenged Claims, the patent discloses exemplary experiments involving leghemoglobin and/or meat replica product aroma.

41. Example 33 discloses addition of “[f]lavor precursors”—various sugars and amino acids—“along with 1% Leghemoglobin” to beef replica products. EX1001, 84:5–31 & Table 8, reproduced below.

TABLE 8

Flavor precursors added to the beef replicas before cooking.			
Additive (mm)	Samples		
	767 Precursor Mix 1	804 No Precursors	929 Precursor Mix 2
Alanine	5.61		5.61
Cysteine	0.83		0.83
Glutamic acid	3.40		3.40
Leucine	0.76		0.76
Lysine	0.68		0.68
Methionine	0.67		0.67
Tryptophan	0.49		0.49
Tyrosine	0.55		0.55
Valine	0.85		0.85
Glucose	5.55		5.55
Ribose	6.66		6.66
Lactic acid	1.00		1.00
creatine	1.00		1.00
Thiamine	0.50		0.50
IMP + GMP	0.40		0.40
Sucrose			2.00
Fructose			2.00
Xylose			2.00
Maltodextrin	0.50%		0.50%

42. Table 9, reproduced below, purports to identify “the sensory score” of the beef replicas compared to conventionally-sourced beef, including “Flavor: Beefy.”

TABLE 9

The sensory score determined by the sensory panel for the replica burgers and 80:20 beef sample.					
		Sample #			
		Beef	767	804	929
Flavor Quality	mean	7.0	3.8	3.2	4.3
	STDEV	0.0	1.3	1.0	1.2

Flavor Intensity	mean	4.3	4.2	4.3	4.3
	STDEV	0.8	1.2	1.4	1.2
Flavor: Beefy	mean	5.8	3.3	2.3	4.2
	STDEV	1.0	1.2	0.8	1.2
Flavor: bloody/Metallic	mean	4.5	2.0	2.2	3.2
	STDEV	1.2	1.0	0.9	1.4
Flavor: Savory	mean	3.3	3.8	3.7	4.2
	STDEV	1.2	1.2	1.2	1.8
Off Flavors:	mean	1.5	2.3	3.5	2.7
chemical/oxidized/beany	STDEV	0.8	1.2	1.8	1.0

43. Table 10 recites various “[b]eef flavor compounds created in replica burger with 1% LegH and precursor mix 2 as detected by GCMS.” (See ’306 patent cols. 85-86 (EX1001).)

44. Example 17 provides that “[a]dding recombinant leghemoglobin or myoglobin **to chicken** resulted in an increased beef aroma and flavor.” EX1001, 74:27-29.¹

45. Example 16 discloses adjusting particle size in order “to control aroma generation,” as factors such as “tissue unit” size and mixing “had profound effects on the generation of aromatic compounds upon cooking.” (EX1001, 72:28-31.) These “profound effects” include diverse aroma profiles:

In particular, multiple aromatic compounds associated with fruity/grean bean/metallic (2-pentyl-furan); nutty/green (4-methylthiazole); peanut butter/musty (pyrazine, ethyl); raw potato/roasted/earthy (Pyrazine, 2,3-dimethyl); vinegary (acetic acid); spicy/caramel/almond (5-methyl-2-furancarboxaldehyde); creamy (butyrolactone); sweet (2,5-dimethyl-3-(3-methyl butyl) pyrazine); fruity/stale beer (2-cyclopentene-1-one,

¹ Unless otherwise indicated, all emphasis in quoted materials is my own.

2-hydroxy-3-methyl); musty/nutty/coumarin/licorice/walnut/bread (3-acetyl-1H-pyrroline); coconut/woody/sweet (pantolactone); penetrating (1-H-pyrrole-2-carboxaldehyde, 1-methyl); minty (caprolactam); toasty caramel (4H-pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl) aromas appeared only in mixed meat replicas, but not in individual tissue replicas.

(EX1001, 72:28-52.) The patent provides that “the levels to which all of the above compounds accumulated during cooking depended on the sizes of tissue units and how they are mixed (coarse particle size, fine particle size, or very fine particle size (blended)),” and, thus, “it was found that structural organization and particle size of beef tissues modify response of beef tissues to cooking.” (EX1001, 72:53-59.)

C. Prosecution History

46. I understand that U.S. Application No. 14/796,970, which was filed on July 10, 2015 and issued as the '306 patent on August 7, 2018, is a continuation of and claims priority to, International Application PCT/US2014/011361, which is a continuation of and claims priority to U.S. Application No. 13/941,211, filed July 12, 2013, which claims priority under to U.S. Provisional No. 61/908,634, filed November 25, 2013, and to U.S. Provisional No. 61/751,816, filed January 11, 2013.

47. I have reviewed the prosecution history of the '970 application. EX1148. I discuss certain portions of the prosecution below.

1. Jul. 10, 2015 As-Filed Claims

48. The as-filed '970 application included 4 independent claims and 26 dependent claims. Independent claims 1 and 7 are representative and are reproduced below. EX1148, 159. At the time, the claims recited “a beef-like flavor” (claim 1) and “taste like beef” (claim 7), rather than a “beef-like aroma.” The heme protein term of claim 1 was limited to a “heterologous” heme-containing protein.

1. A method for imparting a beef-like flavor to a consumable product, comprising adding, to the consumable, an heterologous heme-containing protein, wherein, after cooking, a beef-like flavor is imparted to the consumable.

7. A method for making a white meat composition taste like beef, the method comprising adding a heme-containing protein to the white meat composition, respectively.

2. Sept. 17, 2015 Non-Final Rejection

49. The Examiner restricted the pending claims into three groups in a first Office Action dated September 17, 2015. EX1148, 191-201. The Examiner noted that the Patent Owner had indicated via telephonic interview its intent to prosecute Group I (claims 1-14), which are “drawn to a method of imparting beef-like flavor to a consumable product by adding a heterologous heme-containing protein to the consumable product.” EX1148, 193, 195.

50. Claims 1-6, 10, and 12 were rejected as anticipated by, or in the alternative, as obvious over Jamieson (“Iroquois Stew with Beef, Chicken, and

Pork”). EX1148, 198. Claims 7-9, 11, and 13 were rejected as anticipated over the Jamieson reference and Foo (“Beef and Scallop Stir Fry”). EX1148, 196-97.

51. The Jamieson reference is of particular relevance to my analysis. Regarding Jamieson, the Examiner observed (EX1148, 198-99):

Jamieson discloses a method for making a Iroquois stew with beef comprising adding beef to a composition of pork, chicken, flour, oil, onion, chicken broth, carrots, bay leaves, all spice and potatoes (Ingredients, Preparation). ***Given Jamieson discloses beef, intrinsically the beef comprises a heme-containing protein including myoglobin.*** Moreover, given the composition would comprise myoglobin from beef, intrinsically the myoglobin would exhibit a VIS spectrum that would be identical to that of myoglobin from an animal and an amino acid sequence at least 70% homologous to that set forth in SEQ ID NO: 1.²

² SEQ ID NO: 1 is attributed to *Vigna radiata*, the mung bean. As argued by Patent Owner during prosecution of the '306 patent application (Remarks dated April 20, 2016), the mung bean sequence is not 70% homologous with bovine myoglobin. EX1148, 1879 (“[I]n order to clarify the record, Applicant notes that SEQ ID NO: 1 in the present application, which corresponds to a non-symbiotic hemoglobin from *Vigna radiata*, does not intrinsically possess at least 70% sequence identity to myoglobin from beef, as the Examiner asserted. Using the BlastP algorithm, available on the ncbi.nlm.nih.gov Website, aligning SEQ ID NO:1 in the

52. The Examiner found that it would be obvious to include a “heterologous” heme-containing protein derived from other species in the Jamieson product (e.g., from other meat sources such as pork and chicken) (EX1148, 199):

While Jamieson discloses the addition of a heme-containing protein (in the form of beef), the reference is silent with respect to a heterologous heme-containing protein. Given broadly, the term ***heterologous means “derived from another species”*** (see Merriam-Webster), since Jamieson discloses the combination of meat species (i.e. pork, chicken and beef), it is clear the limitation requiring a heterologous (e.g. different than from beef) heme-containing protein has been satisfied.

In the alternative, absent evidence to the contrary, it would have been obvious to one of ordinary skill in the art to have added a heme-protein from any source, including a heterologous heme-protein and have arrived at the present invention. Although the heme-protein is obtained from a different source (i.e. beef), the burden shifts to establish an unobvious difference between the claimed product and the prior art product.

present application with NP 776306.1, which is a myoglobin sequence from Bos taurus, results in ‘no significant similarity.’”) Accordingly, like Patent Owner, I disagree with the Examiner on this point.

53. The Examiner noted that, although Jamieson was silent as to “the precise amount of heme-containing protein or myoglobin” in its compositions, adjusting the amount thereof would merely be routine (EX1148, 199):

Given the “beef” flavor of the Iroquois stew is a variable that can be adjusted by varying the amount of beef in the composition, ***one of ordinary skill in the art would have been motivated to adjust, in routine processing, the amount of beef added to the stew, to obtain the desired flavor profile.***

3. December 17, 2015 Amendment and Response

54. In response, on December 17, 2015, Patent Owner amended the claims, adding 15 new claims (claims 31-46). Amendments to claims 1 and 7 are representative and reproduced below. Notably, the Patent Owner amended the “an heterologous heme-containing protein” limitation to instead recite “a heme-containing protein from a non-animal source.” EX1148, 1757. Patent Owner also amended claim 7’s “taste like beef” term to instead recite “a beef flavor and aroma.”

55. The Patent Owner also amended the independent claims to recite a “meat replica” that “comprises one or more plant proteins.”

1. (Currently Amended) A method for imparting a beef-like flavor to a consumable product, wherein the consumable product is a meat replica that comprises one or more plant proteins, comprising adding, to the consumable, a heme-containing protein from a non-animal source, wherein, after cooking, a beef-like flavor is imparted to the consumable.

7. (Currently Amended) A method for making a ~~white~~ meat replica composition having a taste like beef flavor and aroma, wherein the meat replica composition comprises one or more plant proteins, the method comprising adding a heme-containing protein from a non-animal source to the ~~white~~ meat replica composition, ~~respectively~~.

56. Of particular relevance to my analysis herein, the Patent Owner argued (EX1148, 1764):

Jamieson does not disclose a consumable product that is a meat replica and that contains one or more plant proteins, and Jamieson does not disclose adding a heme-containing protein from a non-animal source to such a consumable product. Therefore, Jamieson does not anticipate independent claim 1 as amended.

In addition, ***Jamieson does not contain disclosure that would suggest to a skilled artisan that a heme-containing protein from a non-animal source can impart a beef-like flavor to a meat replica.*** Thus, Jamieson, alone or in combination with the definition cited by the Examiner, do not make obvious independent claim 1 as amended.

4. Feb. 1, 2016 In-Person Interview

57. On February 1, 2016, the Examiner and the Patent Owner's representatives had an in-person meeting summarized below. EX1148, 1835-36. As provided in the interview summary, the purpose of the meeting was to distinguish "heme-containing proteins obtained from animal sources ***and the claimed heme-containing proteins obtained from plant sources.***" EX1148, 1835.

All participants (applicant, applicant's representative, PTO personnel):

(1) ELIZABETH GWARTNEY.

(3) Patrick Brown, Myra Pasek, Alison Davis.

(2) Angela Parsons, Teresa Lavoie and Ian Lodovice.

(4) Michele Jacobson, Erik Kashnikow, Assaf Zilbering.

Substance of Interview

(For each issue discussed, provide a detailed description and indicate if agreement was reached. Some topics may include: identification or clarification of a reference or a portion thereof, claim interpretation, proposed amendments, arguments of any applied references etc...)

February 1, 2015, representatives from Impossible Foods and Attorneys/Agents for Applicants met in person at the USPTO with USPTO Examiners and SPEs to discuss US Application No. 14/796,970 and related cases. In the interview Mr. Patrick Brown discussed the background, mission and technology of Impossible Foods. Ms. Alison Davis demonstrated preparation of raw product of the invention and prepared samples for tasting. Angela Parsons and Ian Lodovice discussed the pending claims and how they differ from the prior art. While no agreements were made, the Examiner and SPE Michele Jacobson agreed to a follow-up telephone interview on February 8, 2016.

On February 8, 2015, Attorneys/Agents for Applicants, Angela Parsons and Ian Lodovice discussed possible claim amendments to distinguish the heme-containing proteins obtained from animal sources and the claimed heme-containing proteins obtained from plant sources. No agreement was reached.

5. Feb. 25, 2016 Final Rejection

58. The Examiner subsequently issued a Final Rejection on February 25, 2016. EX1148, 1837-46. The Examiner rejected amended claims 1-5, 7-9, 11, 12, 31-35, 37-41, and 43-46 as obvious over U.S. Patent Pub. No. 2010/0074998, titled “Meat Substitute Food Product and Process For Preparing the Same,” to Espeleta Vega et al. EX1148, 1840-42. Claims 1-5, 7-9, 11, 12, 31-35, 37-41 and 43-46 were also rejected as obvious over U.S. Patent Pub. No. 2012/0093994, titled “Meat Analog Compositions and Process,” to Hseih [sic] and Huff in view of Proulx et al., *Iron Bioavailability of Hemoglobin from Soy Root Nodules Using a Caco-2 Cell Culture Model*, J. Agric. Food Chem. 1518-1522 (2006). EX1148, 1842-44.

59. Regarding the teachings of the **Espeleta Vega** reference, the Examiner reasoned (EX1148, 1840 (citations omitted)):

Espeleta Vega et al. disclose a method of preparing a meat substitute food product comprising the steps of: (a) hydrating at least one

vegetable protein mixed with water and at least one colorant; (b) mixing at least one meat product (e.g. beef) with the hydrated vegetable protein (e.g. soy or pea); (c) mixing units of texturized material and flavoring units (e.g. beef flavor) to the mixture of meat product and hydrated vegetable protein to obtain a prepared food paste; (d) cooking the prepared paste; and (e) forming the cooked paste to give a presentation similar to a meat product.

Further, Espeleta Vega et al. disclose wherein flavoring units are added in a dosed manner and can be units with a flavor of meat, i.e. beef[.]

Given Espeleta Vega et al. disclose a meat substitute food product comprising beef, intrinsically the product would include a heme-containing protein (e.g. a hemoglobin or a myoglobin). Moreover, given the composition would comprise myoglobin from beef, intrinsically the myoglobin would exhibit a VIS spectrum that would be identical to that of myoglobin from an animal and an amino acid sequence at least 70% homologous to that set forth in SEQ ID NO: 1.

60. The Examiner observed that the beef incorporated in Espeleta Vega's products is "obtained from an animal source"—e.g., "from" an animal. EX1148, 1841. This is consistent with my view that "animal," as used in the claims of the '306 patent, refers to animal meat obtained through conventional husbandry practices (EX1148, 1840-41):

Regarding the source and process of obtaining (i.e. isolated and purified) the heme-containing product, it is noted that these limitations do not differentiate the meat substitute food product of Espeleta Vega et al. and the product resulting from the claimed method. Even though

the heme-containing protein of Espeleta Vega et al. is obtained from a different source and method, i.e. animal, the burden shifts to applicant to come forward with evidence [sic] establish an unobvious difference between using the claimed heme-containing protein and **one obtained from an animal source**.

61. Regarding the amount of the heme-containing protein in the Espeleta Vega product (“from meat, i.e., an animal source”), the Examiner reasoned (EX1148, 1841):

While Espeleta Vega et al. disclose a meat substitute food product comprising ***heme-containing protein from meat, i.e. an animal source***, the reference is silent with respect to the amount.

Given Espeleta Vega et al. generally disclose the addition of at least one meat product to hydrated vegetable protein and in one example disclose a meat substitute food product comprising approximately 2.5% beef, it would have been obvious to one of ordinary skill in the art to have adjusted, in routine processing, the amount of beef (and resulting heme-containing protein) in the meat substitute food product of Espeleta Vega et al. to obtain the desired balance between texture and flavor.

62. Regarding **Hseih** and **Proulx**, the Examiner reasoned that Hseih disclosed many of the components of a meat analog (EX1148, 1842-43 (citations omitted)):

Hseih et al. disclose a process of for making a structured plant protein product (i.e. meat analog), the process comprising extruding a mixture under conditions of elevated temperature and pressure to form the

structured plant protein product, wherein the structured plant protein product comprises protein fibers that are substantially aligned

Hseih et al. disclose wherein the structured plant protein product may comprises colorants wherein the concentration of colorants is adjusted to match the color of the animal meat to be simulated and a flavoring agent such as an animal meat flavor.

63. Noting that “Hseih et al. is silent with respect to a heme-containing protein from a non-animal source,” the Examiner reasoned that Proulx’s teachings regarding dietary iron supplementation supported the obviousness of fortifying Hseih’s product with heme iron from leghemoglobin found in soybean root nodules, rather than using “animal sourced heme” (EX1148, 1843-44 (citations omitted)):

Proulx et al. teach that iron deficiency is a major nutritional problem and fortification of foods with iron has been a successful strategy for improving iron content of foods. Proulx et al. teach that iron bioavailability is higher from heme iron sources because of lack of inhibition from chelating compounds. Proulx et al. teach that heme iron in the human diet is almost exclusively from animal sources and its intake has been shown to have a positive correlation with iron status. Proulx et al. teach that the incorporation of animal sourced heme iron is often unfeasible because of economic costs and because cultural and religious barrier forbid the consumption of meat.

Proulx et al. teach that heme iron in the human diet is generally present in animal sources as part of hemoglobin and myoglobin but is also found in many invertebrates, bacteria, fungi and in the plant kingdom. Proulx et al. teach leghemoglobin is a heme protein identified in

soybean root nodules. Proulx et al. teach that the bioavailability of hemoglobin from soy root nodules is similar to that of heme iron from animal sources. Proulx et al. teach using plant hemoglobin, i.e. leghemoglobin, as a heme iron source in diets that are consumed by humans.

Given Proulx et al. teach that iron deficiency is a major nutritional problem and that fortification of foods with iron has been a successful strategy from improving iron content, since Proulx et al. teach that bioavailability is higher from heme iron sources including, leghemoglobin from soy root nodules, it would have been obvious to one of ordinary skill in the art to have fortified the structured plant protein product of Hsieh et al. comprising ***no animal protein***, with leghemoglobin from soy root nodules, to obtain a product with improved nutritional status, i.e. bioavailable source of iron.

6. Apr. 20, 2016 Amendment and Response

64. On April 20, 2016, Patent Owner filed a Request for Continued Examination of the '306 patent application. In doing so, Patent Owner amended the claims and added six new claims, including an independent claim. EX1148, 1874-77.

1. (Currently Amended) A method for imparting a beef-like flavor to a consumable product, wherein the consumable product is a meat replica that contains no animal products and comprises one or more plant proteins, comprising obtaining an isolated heme-containing protein; and adding, to the consumable, 0.01%-5% (by weight of the consumable) of the isolated [[a]] heme-containing protein ~~from a non-animal source~~, wherein, after cooking, a beef-like flavor is imparted to the consumable.

7. (Currently Amended) A method for making a meat replica composition having a beef flavor and aroma, wherein the meat replica composition contains no animal products and comprises one or more plant proteins, the method comprising obtaining an isolated heme-containing protein; and adding 0.01%-5% (by weight of the consumable) of the isolated ~~[[a]]~~ heme-containing protein ~~from a non-animal source~~ to the meat replica composition.

47. (New) A method for making a meat replica composition having a beef flavor and aroma, wherein the meat replica composition contains no animal products and comprises one or more plant proteins, the method comprising isolating a heme-containing protein; and adding 0.01%-5% (by weight of the composition) of the isolated heme-containing protein to the meat replica composition.

65. In response to the Examiner's rejections, the Patent Owner argued that Espeleta Vega did not render the claims obvious (EX1148, 1879 (emphasis in original)):

[I]ndependent claims 1 and 7 have been amended herein to require that the meat replica contains no animal products and to require a step in which the heme-containing protein is isolated.

Vega does not disclose a consumable product or a meat replica that contains no animal products, and Vega does not contain disclosure that would prompt one of skill in the art to make a consumable product or a meat replica that contains no animal products. Vega also does not disclose isolating a heme-containing protein or obtaining an isolated heme-containing protein, and Vega does not contain disclosure that would prompt a skilled artisan to isolate a heme-containing protein or to obtain an isolated heme-containing protein.

66. Patent Owner also argued that Hseih in view of Proulx did not render the claims obvious, allegedly because Hseih and Proulx did not teach a motivation to modify or fortify Hseih's products. EX1148, 1879-86. For example, Patent Owner noted (EX1148, 1880-81 (citations omitted)):

[I]ndependent claims 1 and 7 have been amended herein to clarify the steps that are required to impart a beef-like flavor to a consumable product (independent claim 1) or that are required to make a meat replica composition having a beef flavor and aroma (independent claim 7). Both claims now require a step of obtaining an isolated heme-containing protein and adding 0.1 %-5% by weight of the isolated heme-containing protein to the meat replica.

According to Hseih, the "meat analog compositions may optionally comprise animal meat," however, Hseih does not disclose how to impart a meat flavor in meat analogs that lack meat. In fact, Hseih directly correlates the degree of animal flavor in the meat analog with the amount of animal meat present. See, for example, paragraph [0084], which states that

when a significantly vegetarian composition that has a relatively small degree of animal flavor is desired, the concentration of animal meat in a meat analog composition may be about 45%, about 40%, . . . about 2%, or 0% by weight. Alternatively, when a meat analog composition have a relatively high degree of animal meat flavor is desired, the concentration of animal meat may be about 50%, . . . about 70% or about 75%, by weight.

The Examiner acknowledged that Hsieh et al. is silent with respect to a heme-containing protein from a non-animal source.... Hsieh is silent with respect to a heme-containing protein from any source. For example, Hsieh discloses flavoring agents that can be included in a meat analog, but the list of flavoring agents does not include a heme-containing protein (see paragraph [0090]). Hsieh also discloses coloring agents that can be included in a meat analog, but the list of coloring agents does not include a heme-containing protein.

67. In further support of non-obviousness, Patent Owner pointed to a variety of references that, according to Patent Owner, showed that the use of heme iron supplementation was not common or an art-recognized solution. Patent Owner argued (EX1148, 1882):

[A]t the time the present application was filed, iron supplementation of protein-based non-meat alternatives (variously referred to as meat analogs, meat substitutes, and/or meat replicas) was not considered to be an art recognized problem. In fact, the art is replete with examples of commercially available protein-based non-meat alternatives that naturally contain an amount of iron that is essentially equivalent to ground beef (e.g., - 10-15 % Daily Value Iron) and, therefore, are not further supplemented with iron. See Table 1 for a representative list of commercially available products and their iron content in the absence of any supplementation.

68. Patent Owner also asserted that “at the time the present application was filed, iron supplementation of protein-based non-meat alternatives was known and practiced in the art.” EX1148, 1883. Patent Owner listed various commercial

products that are supplemented with iron salts (Table 2) and noted that supplementation with iron salts was “less complex and less expensive” than adding an isolated heme containing protein to a product. EX1148, 1884.

69. Patent Owner also pointed the Examiner to several references which, according to Patent Owner, do not disclose the use of iron or heme proteins in meat analogs and therefore were “further evidence that iron supplementation of protein-based non-meat alternatives was not an art-recognized problem.” EX1148, 1884. The cited references are EP 1759593 (“Van den Briel”) and Asgar et al. (2010, Comprehensive Rev. Food Sci. Food Safety, 9:513-29 (“Asgar”).

70. In closing, Patent Owner pointed the Examiner to an article titled “The Problem with Fake Meat,” “which critiques the flavors of several different currently-available meat substitutes or meat replicas.” EX1148, 1887. According to Patent Owner, “[t]his article highlights the difficulties encountered when trying to impart a beef-like flavor to a food product in the absence of meat, and indicates that, even in 2015, Beyond Meat [Patent Owner’s commercial competitor] was struggling with the flavor profiles of meat substitutes or meat replicas.” EX1148, 1887. Patent Owner asserted that, “given the difficulties . . . for imparting a beef-like flavor to non-meat products, and the less-than-glowing reviews of the Beyond Meat products . . . Applicants believe that the beef-like flavor and aroma imparted by the heme-containing protein as recited in the claimed methods meets a long-felt need in the

art.” EX1148, 1887. I note that Patent Owner cited no data in support of any “long felt need” for the specific aroma purportedly imparted by inclusion of the heme protein.

7. Jul. 12, 2016 Non-Final Rejection

71. On July 12, 2016, the Examiner issued a Non-Final Rejection with respect to the amended claims. The Examiner withdrew the rejection over Espeleta Vega but, despite Patent Owner’s arguments advanced on April 20, 2016, the Examiner maintained the rejection under Hseih and Proulx to claims 1-5, 7-9, 11, 12, 32-43, and 45-52. EX1148, 1944-56.

72. The Examiner largely reiterated the reasoning in her prior rejection regarding Proulx. Regarding Hseih, the Examiner observed, among other things (EX1148, 1948 (citation omitted)):

Hseih et al. disclose wherein the structured plant protein product may comprises colorants wherein the concentration of colorants is adjusted to match the color of the animal meat to be simulated and a flavoring agent such as an animal meat flavor.

Given Hseih et al. disclose a structured plant protein product comprising a flavoring agent including animal meat flavor, it follows that the structured plant protein product would exhibit, upon cooking, meaty flavor notes.

Hseih et al. is silent with respect to a heme-containing protein from a non-animal source.

73. The Examiner also addressed Patent Owner's arguments regarding the purported non-obviousness of the claimed combination with heme proteins. Regarding the Patent Owner's arguments regarding lack of motivation to combine, the Examiner reasoned (EX1148, 1952-53 (citations omitted)):

Here, the motivation to combine the references comes from Proulx et al. Proulx et al. teach that iron deficiency is a major nutritional problem and fortification of foods with iron has been a successful strategy for improving iron content of foods. Proulx et al. teach that iron bioavailability is higher from heme iron sources because of lack of inhibition from chelating compounds. Proulx et al. teach that heme iron in the human diet is almost exclusively from animal sources and its intake has been shown to have a positive correlation with iron status. Proulx et al. teach that the incorporation of animal sourced heme iron is often unfeasible because of economic costs and because cultural and religious barrier forbid the consumption of meat.

74. Regarding the Patent Owner's arguments regarding iron supplementation, the Examiner reasoned (EX1148, 1953-54 (citations omitted)):

While Applicants find that supplementation of protein-based non-meat alternatives was not considered a problem and that many commercially available product contain iron equivalent to ground beef, Applicants have not demonstrated that the product of Hseih et al., with no animal meat, would comprise the same levels or types of iron. Even if Hseih et al. disclosed a composition comprising no animal meat but comparable levels of iron, the idea of iron fortification in food is to add iron to enrich or strengthen the iron content. Given Proulx et al. teach that iron

deficiency is a major nutritional problem and fortification of foods with iron has been a successful strategy for improving iron content of foods, one of ordinary skill in the art would have tried fortifying any foodstuff, including a meat analog, to improve its iron content.

The fact that commercially available protein-based non-meat alternatives are iron fortified with salts and that heme containing molecules have not been previously noticed as food additives, does not negate [Proulx et al., which] clearly teach the use of heme-containing proteins, leghemoglobin to iron fortify foods. Proulx et al. teach that heme iron from plant sources is a value-added product that can provide highly bioavailable iron as a food fortificant.

75. Lastly, the Examiner observed that “[h]ere, Applicants have not established that it is unexpected for heme-containing proteins to contribute to beef-like flavor or that the beef-like flavor of Applicants’ claimed product is only attributable to the addition of heme-containing protein.” EX1148, 1955.

8. Jan. 12, 2017 Amendment and Response

76. On January 12, 2017, the applicant again amended the claims, adding three new dependent claims reciting various sugars and sulfur compounds. EX1148, 2059-78. I note that these newly-added dependent claims represent the Patent Owner’s first effort to claim sugar and sulfur compounds in the methods claimed in the ’306 patent application.

1. (Currently Amended) A method for imparting a beef-like flavor to a consumable product, wherein the consumable product ~~is~~ comprises a meat replica matrix that contains no animal products and comprises one or more plant proteins, comprising ~~obtaining an isolated heme-containing protein; and~~
~~adding, to~~ incorporating into the meat replica matrix of the consumable product[[,]] 0.01%-5% (by weight of the consumable) of ~~the~~ an isolated heme-containing protein, wherein, after cooking, a beef-like flavor is imparted to the consumable product.

7. (Currently Amended) A method for making a meat replica composition having a beef flavor and aroma, wherein the meat replica composition comprises a meat replica matrix that contains no animal products and comprises one or more plant proteins, the method comprising obtaining an isolated heme-containing protein; and ~~adding~~ incorporating 0.01%-5% (by weight of the consumable) of the isolated heme-containing protein ~~to~~ into the meat replica matrix of the meat replica composition.

47. (Currently Amended) A method for making a meat replica composition having a beef flavor and aroma, wherein the meat replica composition comprises a meat replica matrix that contains no animal products and comprises one or more plant proteins, the method comprising ~~isolating a heme-containing protein; and adding~~ incorporating 0.01%-5% (by weight of the composition) of ~~the~~ an isolated heme-containing protein ~~to~~ into the meat replica matrix of the meat replica composition.

77. **Motivation to Combine:** As in its prior response, the Patent Owner made several arguments challenging the Examiner's reasoning. Patent Owner argued first that the Examiner had not established a *prima facie* case of motivation to combine Hsieh and Proulx (EX1148, 2067-68):

The Office has not met its *prima facie* burden to provide some articulated reasoning with a rational underpinning to support that a person of ordinary skill would have combined Hsieh with Proulx.

A skilled artisan would not have had a reason to modify the meat analog of Hsieh with the leghemoglobin of Proulx because:

A. Hsieh provides no reason to modify its meat analogs to include iron or iron in the form of a heme protein for any reason, let alone to improve meat flavor;

B. Proulx provides no reason to fortify a meat analog or any other type of meat alternative with iron; and

C. The prior art does not recognize there is a problem of iron deficiency in of meat analogs or other meat alternatives.

78. [A] Regarding a motivation to modify Hsieh to include iron, Patent Owner argued, among other things (EX1148, 2069):

[A] person of ordinary skill in the art would have understood why Hsieh does not add iron to the Hsieh's meat analog, because it was known in the art that iron can cause deleterious off-odor consequences (e.g., oxidation and rancidity) in foods and especially meat products. See, for example, Calkins et. al. ((2007, "A fresh look at meat flavor," Meat Sci., 77:63-80 . . . and Yancey et al. (2006, "Effects of total iron, myoglobin, hemoglobin, and lipid oxidation of uncooked muscles on livery flavor development and volatiles of cooked beef steaks," Meat Sci., 73 :680-6) see page 686)

79. I note that Patent Owner's comments regarding "deleterious off-odor consequences" of iron supplementation are somewhat inconsistent with Patent Owner's prior observation that multiple commercial food products are, in fact, supplemented with iron.

80. Patent Owner further asserted that “[t]he skilled artisan would not understand what is meant by the term ‘animal meat flavor’ or whether the ‘animal meat flavor’ contains animal products or not” and that “Hseih at least suggests that animal meat is the ‘animal meat flavor’ flavoring agent,” thus, according to Patent Owner, “the Office has not met its burden of identifying a meat replica product that ‘contains no animal products’ and which would exhibit, upon cooking, a beef-like flavor.” EX1148, 2070.

81. **[B]** Regarding motivations taught in Proulx to fortify a meat analog, Patent Owner argued, among other things, that “one of ordinary skill would understand from Proulx’s own later teachings that the inclusion of iron can cause changes in the organoleptic qualities of a food, including causing the food to taste bad through oxidative rancidity.” EX1148, 2071.

82. **[C]** Regarding a purported problem of iron deficiency in meat analogs, Patent Owner reiterated its prior comments regarding the Asgar and Van den Briel references. EX1148, 2072. Patent Owner also pointed to a Rolan reference, asserting (EX1148, 2072-73):

Although clearly focused on providing ground meat and meat analog compositions having improved nutritional properties, Rolan is silent with respect to the desirability of including an iron supplement in a meat analog, and is similarly silent regarding the issue of iron bioavailability in a meat analog or meat alternative, despite the fact that

Rolan discusses various other nutritional aspects of meat and meat analogs. See, for example, paragraphs [0038], [0092] and [0100] in Rolan. Indeed, according to Rolan, “the ground meat compositions of the invention have improved nutritional properties, such as reduced fat and cholesterol, without sacrificing the flavor, texture, mouth feel, and aroma of ground animal meat” (paragraph [0017]), yet the desirability of including an iron source for any purpose, such as for its nutritional supplementation value, for flavor, or for coloring is not discussed.

83. **Reasonable Expectation of Success:** Patent Owner also argued that the Examiner had not established a *prima facie* case of motivation to combine Hsieh and Proulx (EX1148, 2073):

The Office has not met its *prima facie* burden of establishing a reasonable expectation of success in modifying Hsieh with Proulx. . . .

In fact, a skilled artisan would not have had a reasonable expectation of success in modifying the meat analog of Hsieh to include the leghemoglobin of Proulx at least because . . .:

A. The effect of the food matrix on the bioavailability of iron was unpredictable; and

B. The effect of a heme-containing protein on the organoleptic properties of a food product was unpredictable, if not expected to be likely negative.

84. **[A]** Regarding the effect of food matrix on bioavailability, Patent Owner argued that a variety of references were silent as to the desirability of iron supplementation, and argued that Proulx et al. “expressed doubt as to whether

leghemoglobin would perform efficiently as a fortificant in other food matrices.”

EXEX1148, 2074. Patent Owner also pointed to an article by Uauy et al. (2002, J. Nutr. 132:849S-52S, which purportedly concerns “the technical and practical barriers to iron fortification” and teaches that the “most absorbable iron compounds are most reactive with the food matrix [which] limits the amount of iron added to foods and determines in practice their potential biological impact.” EX1148, 2074.

85. **[B]** Regarding the unpredictable effect of heme protein on organoleptic properties of food products, Patent Owner largely reiterated prior arguments and further observed (EX1148, 2076):

Indeed, a person having ordinary skill in the art would understand that heme iron has been associated in the art with oxidation and off-flavors in meat. Also as discussed above, Calkins et al. discloses that “[o]ff-flavor intensity [] was significantly related to pH and heme iron”. Yancey et al. discloses that their results “suggest that livery flavor may be related to total iron content in the gluteus medius, and to myoglobin concentration in the infraspinatus, psoas major, and gluteus medius muscles.” And Brewer discloses that “[h]eme iron facilitates lipid oxidation producing peroxides which are enzymatically decomposed by catalase producing a variety of compounds, some of which contribute off-flavors” ((2006, “The Chemistry of Beef Flavor-Executive Summary,” National Cattlemen's Beef Association, #12814), see page 10).

Given the above art related to the negative organoleptic properties that are associated with heme-containing proteins, including oxidation,

rancidity, and the production of off-flavors, a person of ordinary skill in the art would not have had a reasonable expectation of success that including a heme-containing protein in a meat analog or meat alternative would result in a food product having an acceptable organoleptic profile. In fact, a skilled artisan more likely would have been concerned that including a heme-containing protein would result in the production of undesired organoleptic properties.

9. Apr. 17, 2017 Final Rejection

86. On April 17, 2017, the Examiner issued another Final Rejection. EX1148, 2121-36.

87. **Section 103:** The Examiner reiterated the same rejections as the July Non-Final Rejection under Hseih and Proulx to claims 1-5, 7-9, 11, 12, 32-43, and 45-52. EX1148, 2125-28. She also addressed Patent Owner's Jan. 12, 2017 Remarks. The Examiner reiterated the motivation to combine Hseih with Proulx (EX1148, 2129):

[Proulx] teaches the overall concept of using plant hemoglobin as a plant heme iron source in diets that are consumed by humans. Proulx et al. teach the general concept that heme iron from plants sources can provide highly bioavailable iron as a food fortificant. Given Hsieh et al. is directed to a structured plant protein product (i.e. meat analog) comprising 0% meat, since Proulx et al. teach that heme iron in the human diet is generally present in animal sources as a part of hemoglobin and myoglobin and since Proulx et al. teach the use of heme iron from plant sources as a food fortificant, one of ordinary skill

in the art would have been motivated to try fortifying the structured plant protein product (i.e. meat analog) of Hsieh et al. as taught by Proulx et al.

88. The Examiner rejected Patent Owner's argument that iron could cause deleterious off-odor consequences (EX1148, 2130):

While Calkins et al. note a study relating the off-flavor of specific beef muscles with heme iron and pH content and Yancey et al. note the effects of iron, myoglobin, hemoglobin and lipid oxidation on livery flavor development in cooked beef steaks, there is no disclosure in either reference that would lead one of ordinary skill in the art away from supplementing a ***non-animal protein product***, such as the meat analog of Hsieh et al., with heme iron from plant sources. Hsieh et al. clearly disclose a meat analog product comprising 0% animal meat. Here, Proulx discloses that fortification iron has a ***potential*** negative effect on organoleptic quality of maize product because soluble forms of iron can cause oxidative rancidity. However, Proulx also discloses the successful use of purified soy leghemoglobin as an iron source for the fortification of maize tortillas. Again, there is no disclosure in Proulx that would lead one of ordinary skill in the art away from exploring the use of soy leghemoglobin as an iron source for the fortification of foods.

89. The Examiner rejected Patent Owner's argument that Hsieh taught the inclusion of animal meat (EX11482, 2131):

While Hsieh et al. disclose adding meat . . . to impart animal meat flavor, Hsieh et al. clearly disclose a meat analog product comprising

0% meat wherein the meat analog may comprises flavoring agents such as animal meat flavor. Here, Hsieh et al. use the term “animal meat flavor” in two completely different context [sic]; (1) adding meat to contribute animal meat flavor to a meat analog ([0084]); and (2) adding an animal meat flavor flavoring agent to impart meat flavor to a meat analog ([0090]). It is clear Hsieh et al. disclose two different modes of adding an animal meat flavor to its meat analog. There is no evidence that the flavoring agent, animal meat flavor, would necessarily be an “animal product.”

90. The Examiner again rejected Patent Owner’s argument that Proulx did not teach a motivation to fortify a meat analog with iron, reiterating that, e.g., “Proulx et al. recognizes that iron deficiency is a major nutritional problem and fortification of foods with iron has been a successful strategy for improving iron content of foods,” and that “Proulx et al. teach that bioavailability is higher from heme iron sources including, leghemoglobin from soy root nodules.” EX1148, 2132. Accordingly, “Proulx et al. provides the motivation to try using a heme iron source for the fortification of any food matrix,” including leghemoglobin. EX1148, 2133-34.

91. In connection with this rationale, the Examiner noted that “any judgment on obviousness is in a sense necessarily a reconstruction based upon hindsight reasoning. But so long as it takes into account only knowledge which was within the level of ordinary skill at the time the claimed invention was made, and

does not include knowledge gleaned only from the applicant's disclosure, such a reconstruction is proper." EX1148, 2132.

92. Regarding Patent Owner's arguments that the effect of a heme-containing protein on the organoleptic properties of a food product was unpredictable, if not expected to be likely negative, the Examiner noted that because "Proulx et al. disclose the successful use of leghemoglobin for iron fortification of maize tortillas, since Hsieh et al. teach a meat analog comprising 0% meat, one of ordinary skill in the art would be motivated to try to fortify the meat analog of Hsieh et al., with leghemoglobin, as taught by Proulx et al., with reasonable expectation of success." EX1148, 2134.

93. **Section 112:** The Examiner also rejected the newly-added claims directed to sugar and sulfur compounds under 35 U.S.C. § 112, noting that, although "there is support for claiming that the meat replica may comprise sugars ... ([0154]) and the meat replica may comprises flavor precursor mix with specific combinations of sugars, amino acids and salts [t]here is no support for claiming ... **any** combination of sugars and sulfur compounds. Moreover, while there is support for claiming sulfur compounds including methionine, cysteine and thiamine, when used in combination as part of a flavor precursor mix, there is no support for claiming **any** sulfur compound." EX1148, 2124 (emphasis in original).

10. Oct. 17, 2017 Amendment and Response

94. On October 17, 2017, in response to the Examiner's Final Rejection, the applicant amended the claims. EX1148, 2703-24. Amendments to the independent claims is representative and reproduced below.

1. (Currently Amended) A method for imparting a beef-like aroma flavor to a meat replica matrix consumable product, wherein the ~~consumable product comprises a meat replica matrix~~ [[that]] contains no animal products and comprises one or more plant proteins, a sugar selected from glucose, ribose, sucrose, fructose, xylose, maltodextrin, and combinations thereof, and at least one sulfur compound selected from methionine, cysteine and thiamine, the method comprising

adding incorporating into the meat replica matrix of the consumable product 0.01%-5% (by weight of the meat replica matrix consumable) of an isolated a heme-containing protein to the meat replica matrix,

wherein, after upon cooking of the meat replica matrix, at least two volatile compounds are generated that are associated with a beef-like aroma, thereby imparting a beef-like aroma flavor is imparted to the meat replica matrix consumable product.

7. (Currently Amended) A method for making a meat replica matrix composition having a beef-like ~~flavor and~~ aroma, wherein the ~~meat replica composition comprises a meat replica matrix~~ [[that]] contains no animal products and comprises one or more plant proteins, a sugar selected from glucose, ribose, sucrose, fructose, xylose, maltodextrin, and combinations thereof, and at least one sulfur compound selected from methionine, cysteine and thiamine, the method comprising obtaining a an isolated heme-containing protein; and incorporating 0.01%-5% (by weight of the meat replica matrix consumable) of the isolated heme-containing protein into the meat replica matrix of the meat replica composition, wherein, upon cooking of the meat replica matrix, at least two volatile compounds are generated that are associated with a beef-like aroma.

47. (Currently Amended) A method for making a meat replica matrix composition having a beef-like ~~flavor and~~ aroma, wherein the ~~meat replica composition~~ comprises a meat replica matrix ~~[[that]]~~ contains no animal products and comprises one or more plant proteins, a sugar selected from glucose, ribose, sucrose, fructose, xylose, maltodextrin, and combinations thereof, and at least one sulfur compound selected from methionine, cysteine and thiamine, the method comprising incorporating 0.01%-5% (by weight of the meat replica matrix composition) of a an isolated heme-containing protein into the meat replica matrix of the meat replica composition, wherein, upon cooking of the meat replica matrix, at least two volatile compounds are generated that are associated with a beef-like aroma.

95. **Section 112.** In response to the Examiner’s finding that “there is no support” for claiming incorporating into the meat replica matrix “**any** combination of sugars and sulfur compounds,” and that, although “there is support for claiming sulfur compounds including methionine, cysteine and thiamine, when used in combination as part of a flavor precursor mix, there is no support for claiming **any** sulfur compound,” Patent Owner amended the claims to recite specific sugar and sulfur compounds. EX1148, 2712–13.

96. **Section 103.** Regarding “The Unpredictable, if Not Likely Negative, Effect of the Heme Protein on the Organoleptic Properties of a Meat Replica,” Patent Owner reiterated its prior arguments regarding purported unexpected and negative effects of adding heme proteins, concluding that “a skilled artisan likely would have avoided including heme in the claimed meat replica matrix.” EX1148, 2714-15. According to Patent Owner, “[g]iven the above understanding in the art related to the likely negative effects of heme-containing proteins on organoleptic properties, including oxidation, rancidity, and the production of off-flavors, a person of ordinary

skill in the art would not have a reasonable expectation of success that including a heme-iron-containing protein in a ground beef-like food product would result in a ground beef-like food product having an acceptable organoleptic profile.” EX1148, 2716.

97. Patent Owner also pointed to a supporting declaration by its expert, Keith Cadwallader, in support of the point that “a skilled artisan likely would have avoided including heme in the claimed meat replica matrix.” EX1148, 2714-16. According to Dr. Cadwallader:

This is a significant discovery since a person having ordinary skill in the art would not have anticipated that the inclusion of a heme protein would have any beneficial effect on flavor. In fact, iron, and specifically heme iron, has been most often associated with causing deleterious off-odor consequences in foods and especially meat products (Calkins, 2007).

98. **Secondary Considerations.** Patent Owner argued regarding the existence of “Secondary Considerations” of non-obviousness—specifically, that “The Actual Effect of a Heme Protein on the Organoleptic Properties of a Meat Replica Matrix is Unexpected and Surprising.” EX1148, 2716.

99. According to Patent Owner, the “state of the art” involves meat replica products “which largely fail to replicate the experience of cooking and eating meat.” EX1148, 2716. In contrast, according to Patent Owner, “[t]he present disclosure overcomes the organoleptic deficiencies of current meat analogs and meat

alternatives and provides a consumable product (i.e., containing a meat replica matrix) ***that more accurately mimics the aroma of beef***; see, e.g., Example 33, which describes the production of beef flavors and aromas in replica burgers with the addition of heme and flavor precursors.” EX1148, 2717. Patent Owner further asserted that (EX1148, 2722):

Applicants were the first to discover a method for imparting a beef-like flavor to a consumable product.... A beef-like flavor is imparted to the consumable product by incorporating 0.01 %-5% (by weight of the consumable) of a heme-containing protein into the meat replica matrix and cooking the consumable product.

100. In support of its position, the Patent Owner proffered several declarations from its employees and experts. Patent Owner argued that, based on these declarations, a POSITA “would have understood that such a heme-iron containing protein would likely adversely impact the organoleptic properties of the meat replica matrix.” EX1148, 2723. Further, according to Patent Owner, “the addition of a heme-iron-containing protein to a non-animal-based meat replica matrix provides several unexpected advantages including, for example, mimicking the taste, aroma, flavor, and color of animal meat in a raw state and a cooked state,” and “a skilled artisan would have had no expectation that the addition of a heme-iron-containing protein to a non-animal-based meat replica matrix would result in these beneficial characteristics.” EX1148, 2723-24.

101. Thus, according to Patent Owner (EX1148, 2723):

The record now provides overwhelming evidence of objective indicia that demonstrate the instant claims were not obvious. In particular, the Declarations now of record set forth objective evidence that establishes the surprisingly and unexpectedly improved organoleptic properties, including, in particular, the aroma profile of the claimed ground beef-like food product.

11. Mar. 2, 2018 Telephone Interview

102. The Examiner held a telephone interview with Patent Owner's counsel on March 2, 2018. EX1148, 3274-75. As described in the interview summary:

In the interview, the Examiner suggested claim amendments to clarify the independent claims, 1, 7 and 47. The independent claims (amended) will specifically be directed to methods of imparting beef-like aroma to a meat replica matrix including a step of adding non-animal heme-containing protein to the meat replica matrix. Ms. Parsons will provide claim amendments via e-mail to be incorporated into an Examiner's Amendment in the Notice of Allowability.

12. Apr. 4, 2018 Notice of Allowance

103. On April 4, 2018, the Examiner issued a Notice of Allowance with Examiner amendments. EX1148, 3258-69. The amendment of independent claim 1 is representative and is reproduced below.

Claim 1:

A method for imparting a beef-like aroma to a meat replica matrix, wherein the meat replica matrix ~~contains no animal products and~~ comprises one or more plant proteins, a sugar selected from glucose, ribose, sucrose, fructose, xylose, maltodextrin, and combinations thereof, and at least one sulfur compound selected from methionine, cysteine and thiamine, the method comprising

adding 0.01%-5% (by weight of the meat replica matrix) of a non-animal heme-containing protein to the meat replica matrix,

wherein, upon cooking of the meat replica matrix, at least two volatile compounds are generated that are associated with a beef-like aroma, thereby imparting a beef-like aroma to the meat replica matrix.

104. The Examiner reasoned (EX1148, 3267-68 (citations omitted)):

The prior art of record, Hseih et al., disclose structured plant protein products having protein fibers that are substantially aligned and having a desirable meat-like moisture, texture, mouthfeel, flavor and color . . . Hseih et al. does not disclose a product comprising: (a) 0.01 % -5% by weight of a non-animal heme-containing protein ... (b) compound selected from glucose, ribose, fructose, sucrose, xylose, maltodextrin and combinations thereof; or (c) at least one sulfur compound selected from methionine, cysteine and thiamine.

Proulx et al. teach that the bioavailability hemoglobin from soy root nodules is similar to that of heme iron from animal sources. Proulx et al. teach using plant hemoglobin, i.e. leghemoglobin, as a heme iron source in diets that are consumed by humans. While Proulx et al. provides motivation to include leghemoglobin in a foodstuff, including a structured plant protein product such as disclosed by Hseih et al, the reference is silent with respect to the influence of heme-containing protein on beef associated flavor.

Cerny et al. teach that the Maillard reaction plays a substantial role in flavor generation during the cooking of meat. Cerny et al. teach that besides, thiamine, the precursors ribose and cysteine are important for meat aroma and are consequently employed in the product of meat flavors.

While Cerny et al. disclose that mixtures of ribose and cysteine, when heated, are known to produce flavors associated with meat, ***Applicants have demonstrated that the combination of:*** (a) a heme-containing protein b) compound selected from glucose, ribose, fructose, sucrose, xylose, maltodextrin and combinations thereof; and (c) at least one sulfur compound selected from methionine, cysteine and thiamine ***produces novel*** (i.e, not produced in the absence of heme-containing protein) ***volatile compounds*** associated with a meaty aroma upon heating.

105. Based on my review of the '306 patent prosecution history, I see that the Examiner was not persuaded of the non-obviousness of fortifying a meat replica matrix (e.g., Hseih) with heme protein from a “non-animal” source such as the soy leghemoglobin of Proulx. In fact, the Examiner repeatedly rejected the pending claims over this combination despite Patent Owner’s efforts to change their scope. Rather, the Examiner only allowed the claims following Patent Owner’s reliance on the production of “novel” volatile compounds purportedly associated with “beefy” aroma and produced only when leghemoglobin is included in a reaction mixture with two other chemical compounds (cysteine and ribose). In my opinion, this was error,

as the Examiner did not have the benefit of an objective interpretation of these purportedly “surprising” results.

106. I observe that, upon the Patent Owner’s claim amendments regarding a “non-animal” heme protein, the Examiner withdrew the rejection over a product comprising conventionally sourced beef (Espeleta Vega). But I observe that the Examiner did not discuss the use of other sources “non-animal” meat or proteins, such as, for example, recombinantly-produced proteins that are native to animal muscle tissues or to plants.

VII. CHALLENGED CLAIMS

107. I understand Motif is challenging the validity of claims 1, 3–11, 13–14, 16–24, 26–27, and 29–33 of the ’306 patent (“Challenged Claims”). I have analyzed the Challenged Claims in connection with Motif’s Petition for *inter partes* review that accompanies this Declaration. The Challenged Claims are reproduced below for reference.

Claim 1	
Element No.	Claim Limitation
1[pre]	A method for imparting a beef-like aroma to a meat replica matrix,
1[a]	wherein the meat replica matrix comprises one or more plant proteins,

1[b]	sugar selected from glucose, ribose, sucrose, fructose, xylose, maltodextrin, and combinations thereof, and at least one sulfur compound selected from methionine, cysteine and thiamine,
1[c]	the method comprising adding 0.01%-5% (by weight of the meat replica matrix) of a non-animal heme-containing protein to the meat replica matrix,
1[d]	wherein, upon cooking of the meat replica matrix, at least two volatile compounds are generated that are associated with a beef-like aroma, thereby imparting a beef-like aroma to the meat replica matrix.
Claim 3	
The method of claim 1, wherein the non-animal heme-containing protein has a UV-VIS spectrum that is substantially similar to that of myoglobin from an animal.	
Claim 4	
The method of claim 1, wherein the heme-containing protein is selected from the group consisting of a leghemoglobin, a flavohemoglobin, Hell's gate globin I, an erythrocrucorin, a protoglobin, a cyanoglobin, a chlorocruorin, a truncated hemoglobin, a truncated 2/2 globin, and a hemoglobin.	
Claim 5	
The method of claim 1, comprising incorporating into the meat replica matrix 0.4%-1% (by weight of the meat replica matrix) of the non-animal heme-containing protein.	
Claim 6	
The method of claim 1, wherein the non-animal heme-containing protein is purified.	
Claim 7	
The method of claim 1, wherein at least one of the one or more plant proteins is isolated.	

Claim 8	
The method of claim 7, wherein at least one of the one or more isolated plant proteins is purified.	
Claim 9	
The method of claim 1, wherein the one or more plant proteins are selected from the group consisting of rubisco, pea proteins, lentil proteins, and other legume proteins.	
Claim 10	
The method of claim 9, wherein the pea proteins comprise pea albumin proteins.	
Claim 11	
The method of claim 1, wherein the one or more plant proteins are present in the meat replica matrix in an amount of between 1% and 30% (by weight of the meat replica matrix).	
Claim 13	
The method of claim 1, wherein the meat replica matrix is comprised within a consumable product, wherein the consumable product is selected from taco filling, a casserole, a sauce, a topping, soup, stew, and a loaf, wherein, upon cooking of the consumable product, the at least two volatile compounds are generated in substantially higher amounts than upon cooking of the consumable product lacking the meat replica matrix.	
Claim 14	
14[pre]	A method for making a meat replica matrix having a beef-like aroma,
14[a]	wherein the meat replica matrix comprises one or more plant proteins,
14[b]	a sugar selected from glucose, ribose, sucrose, fructose, xylose, maltodextrin, and combinations thereof, and at least one sulfur compound selected from methionine, cysteine and thiamine,

14[c]	the method comprising obtaining a non-animal heme-containing protein; and incorporating 0.01%-5% (by weight of the meat replica matrix) of the non-animal heme-containing protein into the meat replica matrix,
14[d]	wherein, upon cooking of the meat replica matrix, at least two volatile compounds are generated that are associated with a beef-like aroma.
Claim 16	
The method of claim 14, wherein the non-animal heme-containing protein has a UV-VIS spectrum that is substantially similar to that of myoglobin from an animal.	
Claim 17	
The method of claim 14, wherein the heme-containing protein is selected from the group consisting of a leghemoglobin, a flavohemoglobin, Hell's gate globin I, an erythrocrucorin, a protoglobin, a cyanoglobin, a chlorocrucorin, a truncated hemoglobin, a truncated 2/2 globin, and a hemoglobin.	
Claim 18	
The method of claim 14, comprising incorporating 0.4-1% (by weight of the meat replica matrix) of the non-animal heme-containing protein into the meat replica matrix.	
Claim 19	
The method of claim 14, wherein at least one of the one or more plant proteins is isolated.	
Claim 20	
The method of claim 19, wherein at least one of the one or more isolated plant proteins is purified.	
Claim 21	

The method of claim 14, wherein the one or more plant proteins are selected from the group consisting of rubisco, pea proteins, lentil proteins, and other legume proteins.	
Claim 22	
The method of claim 21, wherein the pea proteins comprise pea albumin proteins.	
Claim 23	
The method of claim 14, wherein the one or more plant proteins are present in the meat replica matrix in an amount of between 1% and 30% (by weight of the meat replica matrix).	
Claim 24	
The method of claim 14, wherein the non-animal heme-containing protein is purified.	
Claim 26	
The method of claim 14, wherein the meat replica matrix is comprised within a meat replica composition, wherein the composition is selected from taco filling, a casserole, a sauce, a topping, soup, stew, and a loaf, wherein, upon cooking of the composition, the at least two volatile compounds are generated in substantially higher amounts than upon cooking of the composition lacking the meat replica matrix.	
Claim 27	
27[pre]	A method for making a meat replica matrix having a beef-like aroma,
27[a]	wherein the meat replica matrix comprises one or more plant proteins,
27[b]	a sugar selected from glucose, ribose, sucrose, fructose, xylose, maltodextrin, and combinations thereof, and at least one sulfur compound selected from methionine, cysteine and thiamine,

27[c]	the method comprising incorporating 0.01%-5% (by weight of the meat replica matrix) of a non-animal heme-containing protein into the meat replica matrix,
27[d]	wherein, upon cooking of the meat replica matrix, at least two volatile compounds are generated that are associated with a beef-like aroma.
Claim 29	
The method of claim 27, wherein the non-animal heme-containing protein has a UV-VIS spectrum that is substantially similar to that of myoglobin from an animal.	
Claim 30	
The method of claim 27, wherein the heme-containing protein is selected from the group consisting of a leghemoglobin, a flavohemoglobin, Hell's gate globin I, an erythrocrucorin, a protoglobin, a cyanoglobin, a chlorocrucorin, a truncated hemoglobin, a truncated 2/2 globin, and a hemoglobin.	
Claim 31	
The method of claim 27, comprising incorporating 0.4%-1% (by weight of the meat replica matrix) of the non-animal heme-containing protein into the meat replica matrix.	
Claim 32	
The method of claim 27, wherein the one or more plant proteins are selected from the group consisting of rubisco, pea proteins, lentil proteins, and other legume proteins.	
Claim 33	
The method of claim 27, wherein the meat replica matrix is comprised within a meat replica composition, wherein the composition is selected from taco filling, a casserole, a sauce, a topping, soup, stew, and a loaf, wherein, upon cooking of the composition, the at least two volatile compounds are generated in substantially higher amounts than upon cooking of the composition lacking the meat replica matrix.	

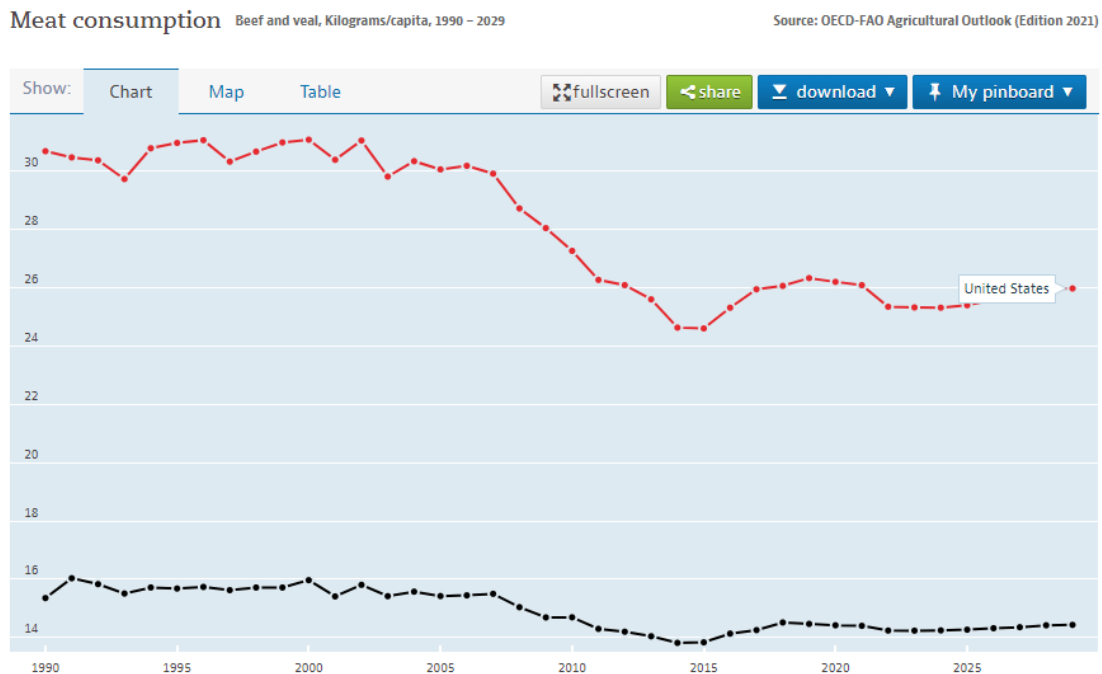
VIII. TECHNICAL BACKGROUND

A. Benefits of Artificial Meat Flavor Additives and Meat Substitutes

1. Meat Consumption

108. Meat has long been an extremely popular food, particularly in the United States. In fact, “[t]he majority of the population in most developed countries consume meat” obtained from conventional practices of animal husbandry and slaughter. EX1029(Williamson), 350.

109. As shown in meat consumption data collected by the Organisation for Economic Co-operation and Development (OECD) below, consumption of beef and veal in the United States far exceeds consumption worldwide.



EX1123(OECD), <https://data.oecd.org/agroutput/meat-consumption.htm>. Despite a decline in meat consumption in the 2000s, inhabitants of the United States continue to consume large quantities of meat, and this trend is projected to continue. Consequently, a POSITA would recognize that many consumers desire meat, whether for its taste, texture, aroma, nutritive benefits, or other advantages.

110. But despite the popularity of meat, there is still a significant number of consumers that avoid meat and meat products in their diets for various reasons, including ethical, environmental, health, personal, and/or religious reasons.

2. Health

111. There is a consumer segment in the market that believes that the husbandry and consumption of animals may affect human health negatively. For example, a significant number of individuals abstain from eating meat because they believe the saturated fat and cholesterol in certain types of meat contain may cause heart disease and other health problems.

Consumer concerns about food-related hazards, food safety risks, and the impact of food consumption on human health have continuously increased during the last decade.

EX1035(Verbeke), 141 (citations omitted).

Survey results ... confirmed product safety concerns to be paramount to concern about animal welfare. A major part of the recent decreases in beef and pork consumption appeared to be associated with growing consumer concerns about product safety. Also this finding is not

surprising, given the large number of safety-crises that hit the meat image during recent years in Belgium (hormones, BSE, antibiotics, tranquilizers, dioxin).

EX1035(Verbeke), 149 (citations omitted).

3. Environment

112. The huge scale of the worldwide enterprise required to raise animals for food in the modern era has triggered concerns among some consumers about these activities' impacts on the environment. These concerns include the amount of land that is dedicated to raise the animals, and the amount of water necessary to sustain the animals themselves and grow their feed, particularly for large animals such as beef cattle.

113. For example, the husbandry of beef cattle requires significant amounts of farmland and water, although estimates vary.

Producing 1 kg of animal protein requires about 100 times more water than producing 1 kg of grain protein. Livestock directly uses only 1.3% of the total water used in agriculture. However, when the water required for forage and grain production is included, the water requirements for livestock production dramatically increase. For example, producing 1 kg of fresh beef may require about 13 kg of grain and 30 kg of hay. This much forage and grain requires about 100 000 L of water to produce the 100 kg of hay, and 5400 L for the 4 kg of grain. On rangeland for forage production, more than 200 000 L of water are needed to produce 1 kg of beef.

EX1036(Pimentel), 662S.

4. Animal Welfare

114. I am aware that certain consumers avoid meat because they are concerned about causing harm or death to animals, and researchers have remarked on this concern increasing in prominence as a factor in the decision of whether to consume meat.

[I]t should be noticed that the welfare issue appears to be associated with consumption decisions that were unfavorable for beef and pork in the past.... [I]t was expected that the ethical issue of animal welfare concern would gain importance in the near future.

EX1035(Verbeke), 149.

115. In light of these varied health and societal concerns among certain consumers, a POSITA would have been motivated to create substitutes for meat products and artificial meat flavoring compositions in order to appeal to this consumer base.

116. Alternatives to animal meat consumption are available for these consumers. One solution is a purely vegetarian diet; however, this may not appeal to consumers who enjoy consuming conventionally sourced meat. These individuals may be more inclined to consume meat substitute products or other foods containing artificial meat flavoring compositions that replicate desirable features of meat, such as meat's characteristic flavor and aroma.

B. Attributes of Meat

117. In recent years, in order to appeal to certain vegetarians, or to encourage meat consumers to change their eating habits, workers in the food technology industry have endeavored to create food products that can successfully substitute for, or mimic, meat products that are obtained directly through conventional practices of animal husbandry and slaughter (*i.e.*, “conventionally obtained” or “conventionally sourced” meat). Use of simulated meat flavoring compositions that can be added to meat substitutes addresses the health, environmental and animal welfare concerns that some consumers may have about producing and consuming meat, while still providing consumers an option that tastes like real meat.

118. To encourage the consumption of meat “replicas”—also called “analogs” or “substitutes”—that contain meat-flavoring compositions, and thereby mitigate these harms, the art taught replicating meat’s natural properties in replica products, including its taste, texture, aroma, appearance, and nutritional profile. As an example of a patent publication from the industry (Solae):

Given the affinity that Americans (and increasingly, others around the world) have for beef patties, ***there is a need for healthy, reduced-fat beef patty products having the sensory properties (e.g., appearance, flavor, and texture) characteristic of all beef patties.***

EX1021(Rolan), [0003].

There have been many attempts to make a healthier beef patty, ranging from all vegetable protein patties to mixtures of beef and vegetable

and/or dairy proteins. Many of these, however, lack the proper moisture, flavor, and texture to be accepted by most consumers. ***What is needed, therefore, is a healthy beef patty*** with lower levels of cholesterol and fat ***that not only has the taste and texture of an all beef patty, but also looks like an all beef patty***. That is, the healthier beef patty should have a reddish color in the raw state and a brownish color in the cooked state, in addition to great flavor and texture characteristics.

EX1021(Rolan), [0004].

The ground meat compositions can be fortified with nutrients, such as vitamins, minerals, antioxidants, omega-3 fatty acids, or other nutrients ***typically found in animal meat products, to produce a food product with the desired nutrient value. The nutrients added to the ground meat and simulated meat are provided to create a product with a nutrient composition comparable to animal meat products.***

EX1021(Rolan), [0100].

1. Nutritional Content of Meat

119. One desirable feature of conventionally obtained meat is its nutritional profile. Lean red meat, which includes beef, is an excellent source of protein, vitamins, and other nutritive materials, such as iron.

Red meat contains high biological value protein and important micronutrients that are needed for good health throughout life. It also contains a range of fats, including essential omega-3 polyunsaturated fats.... While the nutritional composition will vary somewhat according to breed, feeding regimen, season and meat cut, in general

lean red meat has a low fat content, is moderate in cholesterol and rich in protein and many essential vitamins and minerals.

EX1087(Williams), S113.

[I]n general lean red meat is a particularly good source of protein, niacin, vitamin B6, vitamin B12, phosphorus, zinc and iron, with 100g providing more than 25% RDI of these nutrients. It also provides more than 10% RDI of riboflavin, pantothenic acid, and selenium.

EX1087(Williams), S113-14.

Raw red muscle meat contains around 20-25g protein/100g. Cooked red meat contains 28-36g/100g, because the water content decreases and nutrients become more concentrated during cooking.... Protein from meat provides all essential amino acids (lysine, threonine, methionine, phenylalanine, tryptophan, leucine, isoleucine, valine) and has no limiting amino acids.

EX1087(Williams), S114.

Beef and lamb meat are among the richest sources of the minerals iron and zinc, with 100g providing at least one quarter of daily adult requirements ... The iron in meat is mostly haem-iron which is well absorbed, and meat protein also appears to enhance the absorption of iron from meat. Similarly, absorption of zinc from a diet high in animal protein is greater than from plant foods, and the requirements for zinc may be as much as 50% higher for vegetarians ... Red meats are also good sources of selenium, providing over 20% RDI per 100g serve.

EX1087(Williams), S117.

120. Heme-containing proteins (“heme-proteins”) contribute multiple properties characteristic of meat. Meat naturally contains the heme-containing proteins myoglobin and hemoglobin. Myoglobin is an important source of dietary iron.

Meat is an important dietary source of bioavailable minerals and trace elements, in particular iron and zinc. ***Iron plays a major role as an oxygen carrier in haemoglobin in blood, or myoglobin in muscle, and it is also required for many metabolic processes. Dietary iron exists in two forms, haem and non-haem iron, with haem iron being more readily absorbed and utilised by the body. Most of the iron present in meat is in the haem form. Approximately 20–30% of haem iron is absorbed in the intestine, compared with only 7% of non-haem iron.***

EX1029(Williamson), 329.

121. A POSITA would be aware of the relative levels of myoglobin in different meat tissues. Notably, bovine skeletal muscle contains “4 to 10 mg/g” myoglobin and, in “old beef animals, 16 to 20 mg/g.”

In regard to age, the young animal has less myoglobin and relatively more hemoglobin than older animals of the same species. This is shown by ***the following values for myoglobin for fresh bovine skeletal muscle***: veal, 1 to 3 mg/ g; beef, 4 to 10 mg/g; and old beef animals, 16 to 20 mg/g. Pork contains 1 to 3 mg/g for young animals of slaughter weight, but may reach 8 to 12 mg/g in old animals. Lamb may vary from 3 to 8 mg/g, but old ewes and rams may reach levels from 12 to 18 mg/g.

EX1027(Pearson), 65.

2. Color of Meat

122. Heme iron in myoglobin and hemoglobin also serves as a natural pigment, which produces the reddish colors characteristic of blood and meat.

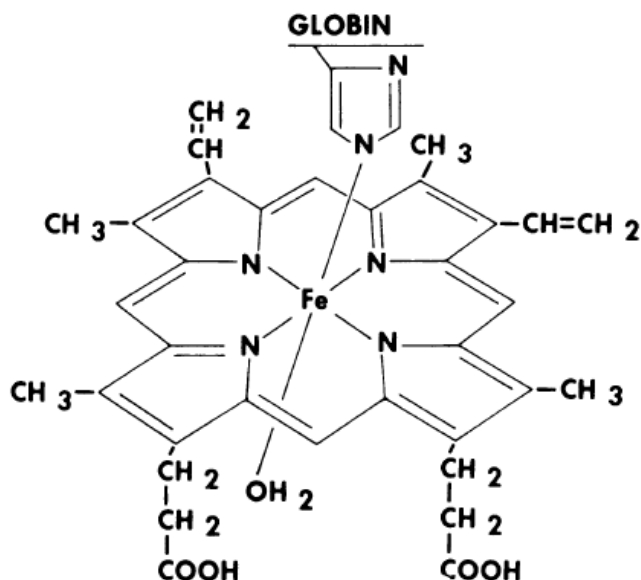
Although hemoglobin is the predominant pigment in the living animal, after slaughter by bleeding, myoglobin becomes the major pigment. Myoglobin accounts for only 10% of the total iron in the live animal, but after bleeding, may account for as much as 95% of the iron in beef skeletal muscle. Nevertheless, hemoglobin is still present in appreciable quantities and may play an important part in meat color.

EX1027(Pearson), 64-65.

Color of the Pigments: In living tissue, myoglobin and hemoglobin exist in equilibrium between the reduced dull purple-red form, myoglobin and hemoglobin, and the bright red oxygenated form, oxymyoglobin and oxyhemoglobin. Upon death, the oxygen in the tissues is rapidly depleted, leaving the pigment in the dull purple-red form of myoglobin or hemoglobin.

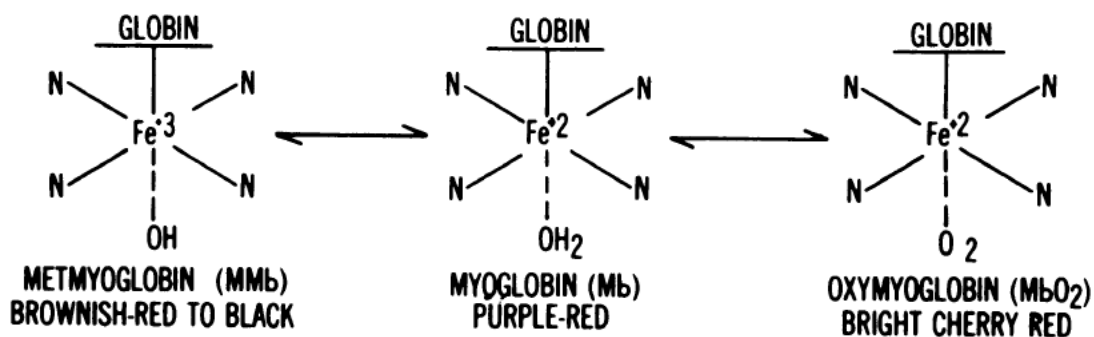
EX1027(Pearson), 66.

123. The following is an exemplary structure for the iron-binding subunit of heme in the myoglobin complex:



EX1027(Pearson), 66. The heme iron serves as a source or sink of electrons during electron transfer, or redox, reactions.

124. As exemplified below, the coloration of myoglobin is affected by the oxidation state of the bound heme iron and the chemical ligand bound to it.



EX1027(Pearson), 67.

125. When heme-containing proteins such as hemoglobin or myoglobin are heated, or cooked, the globin portion is denatured and the heme is converted primarily to a denatured globin hemochrome, which gives the pigment an

irreversible brown hue. EX1107(Science of Cooking) (“Above 140° F, myoglobin loses its ability to bind oxygen, and the iron atom at the center of its molecular structure loses an electron. This process forms a tan-colored compound called hemichrome, which gives medium-done meat its color.”); EX1094(Suman), 82 (“[H]eat-induced Mb[myoglobin] denaturation is responsible for the dull-brown color of cooked meat.”). Heat-reacting sugars and sulfur-containing compounds, like heat-denaturation of myoglobin, also leads to meat’s natural “browning.” EX1028, 65 (“The Maillard reaction, or nonenzymatic browning, helps explain amine and carbonyl reactions in food.”).

126. It was well-known in the art that this color-changing feature (from red to brown) could be implemented into food products. For example, Rolan describes the use of “thermally unstable pigments” and “browning agents” that serve to change from a red color to a brown color when the meat substitute is cooked. EX1021(Rolan), [0081]-[0083]. Conrad teaches the use of hemoglobin to impart a “meat colour.” EX1013(Conrad), 4:3-10.

3. Non-animal Heme-Containing Proteins

127. Non-animal heme-proteins are known to have structural similarities to hemoglobin and myoglobin found in animals.

Leghaemoglobins are plant haemoproteins which resemble animal myoglobins with respect to their molecular weight, monomeric state and their ligand-binding (especially oxygen-binding) properties.

EX1135(Nicola), 133.

There is a high degree of structural homology between myoglobin and leghaemoglobin revealed by sequence alignments

EX1135(Nicola), 139.

The tertiary folding patterns of lupin and soybean Lb are very similar to those of mammalian myoglobins, and the α and β subunits of human hemoglobin.

EX1133(Hargrove), 1032.

128. Also like animal hemoglobin and myoglobin, plant hemoglobins such as leghemoglobin were known to contain heme-iron and have red pigmentation. A POSITA would recognize that these heme-proteins have similar reddish coloration properties as the heme-proteins found in meat.

Plant Hbs were first identified by Kubo (1939). ***This author analyzed the red pigment of soybean root nodules*** From this evidence Kubo concluded that ***the red pigment isolated from soybean root nodules was a hemeprotein....*** Biochemical, biophysical and molecular biology analyses have shown that Kubo's hemeprotein is a plant Hb with similar (i.e. structural) properties to animal Hbs (Fig. 1). ***Kubo's plant Hb was named as leghemoglobin*** (Lb) by Virtanen and Laine (1946) and is also known as plant symbiotic Hb.

EX1030 (Garrocho-Villegas), 79.

129. Plant heme-proteins also have similar nutritional benefits as the heme-proteins found in meat. Recognizing that "iron deficiency is a major nutritional

problem, affecting over 2 billion people,” (EX1019(Proulx), 1518), Proulx and colleagues used plant heme-proteins to fortify foodstuffs. They studied “the effectiveness of soy root nodule (SRN) and purified soy hemoglobin (LHb) in improving iron bioavailability using an in vitro Caco-2 cell model” and concluded that “heme iron from plant sources may be a novel value added product that can provide highly bioavailable iron as a food fortificant.” *Id.* This is due to the fact that plant hemoglobin is characterized by “minimal inhibition of heme iron, unlike nonheme iron, by dietary factors and because of the high heat stability of this iron.” *Id.*, 1522. Proulx demonstrated that “the bioavailability of hemoglobin from soy root nodules is similar to that of heme iron from animal sources when added with tortillas.” *Id.*, 1521. Thus, it “provide[s] a unique alternative fortificant...to improve the iron status of the population.” *Id.*

130. Based on their experiments, these researchers assessed that “[g]iven optimal nodulation conditions, 2-3 plants would provide sufficient LHb to meet 25% of the recommended daily requirement of iron, assuming 25% of heme iron absorption.” EX1019(Proulx), 1522. Thus, soy root nodules can be a “novel value-added product for soy producers.” *Id.*

C. **Recombinant Technology**

131. Scientists and researchers have long recognized the feasibility and the value of using recombinant technologies to engineer proteins for use in food

products. I understand that Motif's expert Dr. Batt produced recombinant whey protein for this purpose, for example. EX1007 paragraph 49. For instance, scientists had engineered plants fortified with high levels of iron-containing proteins using transgenic expression systems. One early example of using recombinant technology to achieve this goal was a late-1990s study of the fortification of rice using genetic engineering. See EX1046(Goto). Goto and colleagues recognized that "[i]ron deficiency is a serious nutritional problem that afflicts an estimated 30% of the world population[], especially where vegetable-based diets are the primary food source." *Id.*, 282. To address this problem, they expressed the soybean ferritin gene in transgenic rice (*Oryza sativa*) using familiar genetic engineering techniques. They observed that "ferritin is used by both plants and animals as the storage form of iron[] and that, orally administrated, it can provide a source of iron for treatment of rat anemia." *Id.*

132. These researchers observed that "soybean ferritin could be highly expressed and accumulated in the endosperm tissue of heterogeneous rice plants," and that "transgenic seeds stored up to three times more iron than the normal seeds." EX1046(Goto), 282, 285 ("[T]he seeds from the transgenic rice accumulated up to threefold more iron ... than normal seeds This achievement suggests that it may be feasible to produce 'ferritin rice' as an iron supplement in the human diet."). They

recognized that “increasing the ferritin content of cereals by genetic engineering may help to solve the problem of dietary iron deficiency.” *Id.*, 282.

133. It was also well-known in the art that heme-containing proteins, such as hemoglobin, myoglobin, and soy leghemoglobin, could be produced using recombinant technology, such as using recombinant yeast or bacterial expression systems. *See generally* EX1014(Crane). Additionally, as shown in the Proulx reference, the heme-protein leghemoglobin could be extracted and purified from plants (soybean root nodules) in order to fortify foodstuffs.

D. Meat Flavor Chemistry

134. Heme-proteins were also known to contribute to the flavor of meat. As I discuss further below, for example, the “addition of blood/hemoglobin” was observed to “improve[] the meat flavour” of meat replicas. EX1013, 4:14–16 ; *infra* §XII. Additionally, as disclosed in a patent publication to Yamaguchi and others, iron, including heme iron and iron from “blood cell powder,” was recognized to have “body taste-improving effect” and the ability to enhance the “rich” taste of savory foodstuffs, including meats. EX1022, [0023] (pork), [0026]–[0028], [0031]–[0033], [0057], [0059] (hamburger). The Yamaguchi reference’s named inventors reported on their research using iron in certain foodstuffs and concluded that “all the strength of *aroma, flavor and taste was increased by the existence of Fe component* [iron]”

in foodstuffs. EX1022, [0062]–[0101]; EX1005 Section V.D.3 and paragraphs 130–131.

135. It has long been known in the art that the products of what are known as Maillard reactions—chemical reactions between sulfur-containing amino acids and sugars—are in large part what give browned meats, in particular beef, their distinctive flavor. I am familiar with the Maillard reaction and other principles of flavor chemistry. I understand that Motif’s expert Dr. Robert McGorin has provided a review and analysis of meat flavor chemistry in this Proceeding. I have reviewed the McGorin Declaration, EX1005. Dr. McGorin’s analysis of meat flavor chemistry principles is consistent with my understanding and I rely on his analysis in forming my opinions in this Declaration.

IX. SUMMARY OF THE PRIOR ART

A. Boye (EX1016)

136. I have reviewed Boye et al., titled “Pulse proteins: Processing, characterization, functional properties and applications in food and feed,” which published in the journal Food Research International in 2010, pages 414-431. I understand that Boye is considered prior art under at least pre-AIA 35 U.S.C. §102(b) because it is a printed publication published more than one year before the effective filing date of the ’306 patent. As I am at least a person of ordinary skill in the art, I am familiar with the journal Food Research International, as well as its

publisher, Elsevier. Elsevier is a well-known and world-renowned non-profit scientific society that was founded in 1876. By 2010, Elsevier was (and still is) a leading source of scientific information within the field of food science and publishes dozens of peer-reviewed scientific journals. In particular, Food Research International has, for decades, been a highly-reputable scientific journal within the field of food science. By 2010, a POSITA would have considered the publication dates printed on the face of the journal and the paper itself to be a reliable indicator of its publication date. Thus, it is my opinion that the Boye reference was available to a POSITA exercising reasonable diligence by 2010.

137. As discussed further below, Boye teaches that “pulses,” such as peas, “are an important source of food proteins,” and, given “growing global food security challenges and protein malnutrition,” pulses “may offer a promising alternative source for nutritional and functional proteins.” EX1016, Abstract. In particular, “[p]ulses constitute an important source of dietary protein for large segments of the world’s population particularly in those countries in which the consumption of animal protein is limited by nonavailability or is self-imposed because of religious or cultural habits.” EX1016, 415. Notably, “[f]rom the nutritional perspective, pulses are of particular interest because they contain high amounts of protein.” EX1016, 415.

A. Cho (EX1140)

138. I have reviewed U.S. Patent Application Publication No. 2008/0008815 to Cho, (“Cho”) which published on January 10, 2008. I understand that Cho is considered prior art under at least pre-AIA §102(b) because it is a printed publication published more than one year before the effective filing date of the ’306 patent. As discussed further below, Cho teaches “processes for producing the bland tasting [non-objectionable] soy protein isolates,” which “have very low levels of fat and volatile compounds that cause off-flavors in soy and are particularly suited for application in any number of food and drink products that incorporate soy proteins.” EX1140, Abstract.

B. Crane (EX1014)

139. I have reviewed U.S. Patent Publication No. 2011/0287467 to Crane and Sudhamsu (“Crane”), which published on November 24, 2011. I understand that Crane is considered prior art under at least pre-AIA 35 U.S.C. §102(b) because it is a printed publication published more than one year before the effective filing date of the ’306 patent.

140. As discussed further below, Crane teaches “methods of producing recombinant functional heme-binding proteins with complete heme incorporation and purified preparations” thereof. EX1014, Abstract. Crane discloses that “the methods of the present invention generate recombinant heme-binding proteins that

have complete heme incorporation,” and, “[t]herefore, these proteins are completely functional and are more suitable for research, clinical, and commercial applications.” EX1014, [0024].

C. Conrad (EX1013)

141. I have reviewed U.S. Patent No. 4,818,557 to Conrad, titled “Bran-Gluten Meat Replacement Product and Meat Products Comprising Same,” which bears a “date of patent” of April 4, 1989 (“Conrad”). I understand that Conrad is considered prior art under at least pre-AIA 35 U.S.C. § 102(b) because it is a printed publication published more than one year before the effective filing date of the ’306 patent.

142. As discussed further below, Conrad teaches “a meat replacement product to be used in mixed minced meat products, process for its preparation, and meat products comprising same, whereby the meat replacement product comprises the gluten protein and the bran fractions of whole cereal grain,” and to which “a blood hemoglobin fraction can be added.” EX1013, Abstract.

D. Mottram (EX1017)

143. I have reviewed Mottram, titled *Flavour formation in meat and meat: a review*, and published in volume 62 of the journal Food Chemistry, pages 415-424, in 1998. I understand that Mottram is considered prior art under at least pre-AIA 35 U.S.C. § 102(b) because it is a printed publication published more than one year

before the effective filing date of the '306 patent. As I am at least a person of ordinary skill in the art, I am familiar with the journal Food Chemistry, as well as its publisher, Elsevier. By 1998, Elsevier was (and still is) a leading source of scientific information within the field of food science and publishes dozens of peer-reviewed scientific journals. In particular, Food Chemistry has, for decades, been a highly-reputable scientific journal within the field of food science. By 1998, a POSITA would have considered the publication dates printed on the face of the journal and the paper itself to be a reliable indicator of its publication date. Thus, it is my opinion that the Mottram reference was available to a POSITA exercising reasonable diligence by 1998.

144. As discussed further below, Mottram teaches that “[t]he characteristic flavour of cooked meat derives from thermally induced reactions occurring during heating, principally the Maillard reaction and the degradation of lipid,” and that “[h]eterocyclic compounds, especially those containing sulfur, are important flavour compounds produced in the Maillard reaction providing savoury, meaty, roast and boiled flavours.” EX1017, Abstract.

E. Proulx (EX1019)

145. I have reviewed “*Iron Bioavailability of Hemoglobin from Soy Root Nodules Using a Caco-2 Cell Culture Model*,” by Amy K. Proulx and Manju B Reddy, published in Food Science and Human Nutrition on January 31, 2006

(“Proulx”). I understand that Proulx is considered prior art under under at least pre-AIA 35 U.S.C. § 102(b) because it is a printed publication published more than one year before the effective filing date of the ’306 patent. As I am at least a person of ordinary skill in the art, I am familiar with the Journal of Agricultural and Food Chemistry, as well as its publisher, the American Chemical Society (“ACS”). ACS is a well-known and world-renowned non-profit scientific society that was founded in 1876. By 2006, ACS was (and still is) a leading source of scientific information within the field of food science and publishes dozens of peer-reviewed scientific journals. In particular, the Journal of Agricultural and Food Chemistry has, for decades, been a highly-reputable scientific journal within the field of food science. By 2006, a POSITA would have considered the publication dates printed on the face of the journal and the paper itself to be a reliable indicator of its publication date. Thus, it is my opinion that the Proulx reference was available to a POSITA exercising reasonable diligence by 2006.

146. As discussed further below, the Proulx article generally relates to the use of plant-derived soy leghemoglobin to fortify non-animal food products. *See* EX1019, Abstract. Proulx explains that “[i]ron deficiency is a major nutritional problem, affecting 2 billion people.” *Id.*, 1518. “Heme iron in the human diet is generally present in animal sources as a part of hemoglobin and myoglobin,” but are also “widely distributed in the plant kingdom.” *Id.* For example, “[l]eghemoglobin

(LHb), a symbiotic hemoglobin, is a monomeric heme protein originally identified in soybean root nodules.” *Id.* Proulx focuses on “the use of plant hemoglobins for improving iron bioavailability of human diet” (*id.*), because “the incorporation of animal-sourced heme iron is often unfeasible because of economic costs or because [of] cultural and religious barriers.” *Id.*, 1521.

147. The objective of Proulx’s study “was to determine the iron bioavailability of crude soy root nodule extract (SRN) and two purified soy leghemoglobins” and “compare their bioavailability of bovine hemoglobin (BHb).” EX1019, 1521. Proulx’s underlying objective “is to introduce the concept of using plant hemoglobin as a heme iron source in diets that are consumed by humans.” *Id.* The results of the study showed that “the bioavailability of hemoglobin from soy root nodules [is] similar to that of heme iron from animal sources” and can “provide a unique alternative fortificant” and “improve the iron status of the population.” *Id.*, 1521.

B. Rovaart (EX1125)

148. I have reviewed Rovaart, which issued on December 30, 1975. I understand that Rovaart is considered prior art under at least pre-AIA 35 U.S.C. §102(b) because it is a printed publication published more than one year before the effective filing date of the ’306 patent.

149. As discussed further below, Rovaart teaches methods “for preparing an expanded porous food product having a meat-like flavour,” including by heating a mixture containing “(b) a sulphur compound such as a sulphur-containing amino-acid, [and] (c) a pentose or hexose.” EX1125, Abstract. Rovaart teaches that “[s]tarting from a substance rich in protein ... the final product has a fibrous structure analogous to the texture of meat and a meat-flavour.” EX1125, 3:13-16. Rovaart teaches various embodiments of its method, including exemplary methods which “provide[] a product having the flavour of boiled beef and a meat like texture.” EX1125, 5:29-34.

X. SUMMARY OF OPINIONS

150. In my opinion, claims 1, 3–11, 13–14, 16–24, 26–27, and 29–33 of the ’306 patent are unpatentable based on the following grounds:

No.	Claims	Grounds for Challenge
1	1, 3–9, 11, 13–14, 16–21, 23–24, 26–27, and 29–33	Conrad, Mottram, Crane
2	1, 3–9, 11, 13–14, 16–21, 23–24, 26–27, and 29–33	Conrad, Mottram, Proulx
3	1, 3–9, 11, 13–14, 16–21, 23–24, 26–27, and 29–33	Rovaart, Conrad, Crane

No.	Claims	Grounds for Challenge
4	1, 3–9, 11, 13–14, 16–21, 23–24, 26–27, and 29–33	Rovaart, Conrad, Proulx
5	7–8, 19–20	Rovaart, Conrad, Crane/Proulx, Cho
6	7–8, 19–20	Conrad, Mottram, Crane/Proulx, Cho
7	9–10, 21–22, 32	Conrad, Mottram, Crane/Proulx, Boye
8	9–10, 21–22, 32	Rovaart, Conrad, Crane/Proulx, Boye

XI. CLAIM CONSTRUCTION

A. Preamble

Claim 1: “A method for imparting a beef-like aroma to a meat replica matrix,...”

Claim 14: “A method for making a meat replica matrix having a beef-like aroma,...”

Claim 27: “A method for making a meat replica matrix having a beef-like aroma,...”

151. I have considered the preambles to the '306 patent claims. I am informed and understand that, generally, a preamble of a patent claim is considered to not “limit” a patent claim. I am informed and understand, for example, that the preamble is not limiting if the patentee defines a structurally complete invention in

the claim's body and uses the preamble only to state a purpose or intended use for the invention.

152. I am also informed and understand that there are several exceptions to the general rule that a preamble is not limiting—for example, that a preamble is limiting if: it recites additional structure or steps underscored as important by the specification; if it is essential to understand limitations or terms in the claim body; if it provides antecedent basis for a subsequent structural claim limitation; or if it provides necessary structure that is absent from the body of the claim.

153. In my opinion, none of the exceptions to the general principle (that the preamble is not limiting) are relevant to the claims of the '306 patent. As a POSITA would recognize, following the preamble, the body of the claims defines a structurally complete invention. These claims recite methods covering the combination of individual components that purportedly give rise to the beef-like aroma—the claimed sugar and sulfur compounds (Maillard reaction precursors), one or more plant proteins, and 0.01-5.0% “non-animal” heme-containing protein—and the cooking thereof. The cooking of the Maillard reaction precursors, as discussed more extensively in Dr. McGorin's Declaration, produces at least two (and in fact many more) volatile compounds known to be associated with beef-like aroma, as recited in the body of the claims. The claims' preamble does not recite any additional structure that is important or necessary to perform the claimed methods.

154. Rather, the preamble of the '306 patent claims only states a purpose or intended use for the subject matter recited in the body of the claimed methods—that is, imparting a beef-like aroma to a meat replica matrix, or making a meat replica matrix having a beef-like aroma. Step [d] of these claims recites similar subject matter, e.g., the generation of at least two volatile compounds associated with a beef-like aroma. Thus, the preamble is not essential to understand any limitations or terms in the body of the claims.

A. **“thereby imparting a beef-like aroma to the meat replica matrix”**

155. I am informed and understand that claim language without any bearing on the claimed methods should be deemed non-limiting when it does not result in a “manipulative difference” in the steps of the claim, or if it merely expresses a purpose for or intended result of the claimed method.

156. In my opinion, the term “thereby imparting a beef-like aroma to the meat replica matrix” (claim 1 and dependent claims) is not limiting. Based on my review of the specification, the term “beef-like aroma” is neither defined nor requires any particular characteristics in the context of a meat replica matrix. The claimed methods recite specific steps that achieve this aroma. E.g., the methods recite certain ingredients in the claimed meat replica matrix, particularly Maillard precursors (“a sugar selected from glucose, ribose, sucrose, fructose, xylose, maltodextrin, and combinations thereof, and at least one sulfur compound selected from methionine,

cysteine and thiamine”). The claimed methods also recite that, “upon cooking of the meat replica matrix, at least two volatile compounds are generated that are associated with a beef-like aroma.” The resulting aroma of the cooked meat replica matrix is merely the purpose and intended result of the steps of cooking Maillard precursors in that matrix.

157. To the extent this term is limiting, as taught in Mottram and explained by Dr. McGorin, cooking Maillard precursors (e.g., ribose and cysteine) naturally produces such compounds, including volatile compounds characteristic of beef-like aroma such as the character-impact compounds MFT and MFT-MFT. EX1005(McGorin) paragraphs 53, 112 and Sections V, VII; EX1017(Mottram). As a POSITA would recognize, the generation of these volatiles naturally imparts “a beef-like aroma” to the claimed meat replica matrix.

B. “non-animal”

158. The challenged claims require that the meat replica matrix comprises a “non-animal” heme-containing protein. As discussed below, I understand Patent Owner has taken the position that the term “non-animal” should be interpreted to allow the use of proteins that are native to an animal species, *Bos taurus* (the domesticated cow) but are not obtained from a previously live animal.

159. I have reviewed Patent Owner’s Second Amended Complaint (“SAC”) which I understand to have been filed in the co-pending Litigation. See

EX1116(SAC). From my review of the SAC, I understand that Patent Owner has alleged that certain Motif products, which contain “myoglobin produced by fermentation from a modified strain of *Pichia pastoris* expressing the myoglobin gene from *Bos taurus*,” practice claim 1 of the ’096 patent. *Id.*, ¶32. I am further informed and understand that a claim term such as “non-animal heme-containing protein” should be given the same interpretation when determining a patent’s validity, as in this present *inter partes* review proceeding, as when determining whether the patent is infringed (as in a district court litigation). Thus, based on Patent Owner’s interpretation, Grounds 1 and 3 (for example) below map “non-animal heme-containing protein” to heme-proteins (hemoglobin and myoglobin) produced recombinantly (*i.e.*, from a non-animal source). I note that even if Patent Owner’s interpretation of this term is not adopted, Grounds 1 and 3 are unaffected because they also alternatively map “non-animal heme-containing protein” to leghemoglobin, which is a heme-containing protein native to plants.

C. “meat replica matrix”

160. Based on my review of the ’306 patent specification, the specification does not define the term(s) “matrix” or “meat replica matrix” recited in claims 1, 14, and 17 (and their dependent claims). In my opinion, these limitation(s) should be given their plain and ordinary meaning and need not be construed. According to the ordinary and customary use of these terms in the art, a POSITA would understand

that they refer to the mixture of components in a meat replica. For example, the '306 patent specification states:

Proteins also can be assembled into fibers that can form a matrix for a structure for the compositions. A 3-dimensional matrix of protein fibers can, for example, contain chemicals that promote formation of inter-molecular disulfide cross-links ...

EX1001('306 patent), 25:28-29. The patent provides that other forms of materials can form the matrix, e.g., “lecithin may disrupt the ***protein/fat matrix*** to make a less stable emulsion” (EX1001('306 patent), 34:44-47), and “[e]mulsification forms a homogenous mixture of the fat held in a ***matrix*** of ***proteins and lecithin.***” EX1001('306 patent), 36:20-22.

161. Accordingly, to the extent construction is needed, consistent with the specification and claims of the '306 patent, a POSITA would understand the term “meat replica matrix” to generally refer to the components of a meat replica.

XII. GROUND 1: CONRAD, MOTTRAM, CRANE

162. In my opinion, claims 1, 3–9, 11, 13–14, 16–21, 23–24, 26–27, 29–33 of the '306 patent are obvious over Conrad in view of Mottram and Crane.

163. As I discuss further below, Conrad, Mottram, and Crane references are analogous art to the '306 patent. The '306 patent describes its purported invention as follows (EX1001('306 patent), 1:25-29):

This invention relates to consumable products and more particularly, to non-animal based replicas of animal-based food products, that can be produced, in some embodiments, by breaking down non-animal materials into their constituent parts and reassembling those parts into the consumables.

164. In its Background section, the '306 patent discloses various motivations to make “non-animal” foods, including the negative environmental effect of animal farming and harms to human health. EX1001('306 patent), 1:33-50. The '306 patent also asserts that, among other things, meat substitutes have failed to motivate consumers of conventionally-sourced meat to instead consume plant-based meat replicas because these plant-based products are inadequate to replicate characteristics of natural meat, including meaty aroma (EX1001('306 patent), 1:56-2:3):

Plant based meat substitutes have largely failed to cause a shift to a vegetarian diet. The current state of the art for meat substitute compositions involves the extrusion of soy/grain mixture, resulting in products which largely fail to replicate the experience of cooking and eating meat. Common limitations of these products are a texture and mouthfeel that are more homogenous than that of equivalent meat products. Furthermore, as the products must largely be sold pre-cooked, with artificial flavors and aromas built in, ***they fail to replicate aromas, flavors, and other key features associated with cooking meat.*** As a result, these products appeal mainly to a limited consumer base

that is already committed to vegetarianism/veganism, but have failed to appeal to the larger consumer segment accustomed to eating meat.

165. The '306 patent also claims that “[d]isclosed herein are improved methods and composition for the production of consumables.” EX1001('306 patent), 2:50-55.

166. From my review of the '306 patent, the problem facing the '306 patent inventors relates to the desirability of making “improved” meat replica products that, as a result of having “improved” meat-like properties, would likely appeal to a broader swath of consumers and motivate them to shift away from consuming conventionally-sourced animal meat.

167. **Conrad**, which relates to a “Bran-Gluten Meat Replacement Product” (see title), is analogous art to the '306 patent. Conrad is in the same field of endeavor as the '306 patent (e.g., foodstuffs, particularly plant-based meat replica products) and is reasonably pertinent to the problem facing that patent’s inventors because Conrad recognizes various benefits of developing plant-based meat substitute foodstuffs that will appeal to consumers who would otherwise consume real meat products.

168. For example, recognizing the undesirable high cost of animal meat, Conrad provides that “replac[ing] some of the *animal meat tending to be somewhat expensive* with...protein rich vegetable product,” “would be desirable ... from a cost benefit point of view....” EX1013(Conrad), 1:25-40.

169. Conrad also teaches nutritional advantages of its products, which provide dietary fiber. Conrad teaches that people consume “*too little fibre*” and “only have half the daily intake which is regarded necessary to obtain a correct intestinal function”—thus, plant-based meat replicas, which contain fiber are also “desirable from a nutritional point of view.” EX1013(Conrad), 1:25-40. As taught in Table 1 of Conrad (excerpted below), its “wheat meat” contains 14% “Bran-fiber” in “Wheat Meat” compared to 0% Bran-fiber in real meat.

TABLE 1			
Compound	Meat		
	Beef	Swine	Wheat meat
Water	73%	65%	65%
Starch	0%	0%	3%
Bran-fiber	0%	0%	14%
Proteins	22	19%	15%
Fat	3%	12%	0%
Wheat germ incl. wheat germ oil	0%	0%	2.5%
Salts	2%	4%	0.5%
	100%	100%	100%

Thus, Conrad motivates a POSITA to pursue plant (grain)-based meat replicas.

170. Conrad teaches that its meat replica “grain meat”/ “wheat meat” comprises hemoglobin (heme-protein) sourced from slaughtered-animal blood, and that including hemoglobin is advantageous in several respects. EX1013(Conrad), 1:56-61; 4:3-17. According to Conrad, for example, “*addition of blood/hemoglobin further gives a desired taste improvement as it improves the meat flavour of the final product*” and “colour [of wheat meat] *can advantageously be transferred into*

meat colour by adding thereto ***up to 15% by weight of blood.*** EX1013(Conrad), 4:3-17.

171. Conrad’s meat replacement product (“grain meat”/“wheat meat”), which maps to the claimed “meat replica matrix,” is used to partially replace real meat in consumables. EX1013(Conrad), 1:15-18(“The object of the present invention is to replace some of the contents of mixed meat products with meat replacement products...”). Thus, Conrad’s consumable embodiments (e.g., sausage, meatballs) also contain real meat, as described in Examples 2 and 3.

172. Because Conrad’s “grain meat” is used to partially replace meat in a meat-like consumable, a POSITA would be strongly motivated to closely mimic real meat’s characteristics in Conrad’s product. As I discuss further below regarding limitation [b] of claims 1, 14, and 27, a POSITA would be generally motivated to enhance the “meat-like” nature of Conrad’s meat replacements in order to provide the desirable experience of consuming an entirely-meat foodstuff while achieving the other advantages of Conrad’s meat replacement (e.g., reduced expense and increased dietary fiber).

173. I note that Conrad’s “grain meat”/ “wheat meat” “meat replica matrix” is *itself* meat-free. EX1013(Conrad), Table 1 (“wheat meat” recipe). Based on my review of the ’306 patent claims, however, they do not exclude the presence of meat in, for example, a food product (consumable) that contains the meat replica matrix.

Moreover, I understand from the prosecution of the '306 patent that its claims were amended to delete the limitation that the meat replica matrix “contains no animal products” and instead add the term “non-animal” to modify only the “heme-containing protein” limitation. EX1148, 1879; 1757; 3274-75. .

174. **Mottram**, a review article titled “Flavour formation in meat and meat products: a review,” discusses meat flavor science and its application in industrial food production. EX1017(Mottram), 415 (“***[D]esirable characteristics of meat flavour*** have also been sought ***in the production of simulated meat flavourings which are of considerable importance in convenience and processed savoury foods.***”); *id.* at 416 (discussing industrial development of “‘reaction product’ meat flavorings”).

175. Mottram is analogous art as it is in the field of endeavor of the '306 patent as it relates to the preparation of foodstuffs and is reasonably pertinent to the problem facing the named inventors of that patent at least because Mottram teaches that, when cooked, sugars and sulfur-containing compounds generate meaty aroma-associated volatile compounds and thereby contribute meaty flavor to foods (e.g., to meat). EX1017(Mottram), 415 (“***The characteristic flavour of cooked meat derives from*** thermally induced reactions..., principally ***the Maillard reaction***...”). This teaching is relevant to the development of plant-based foodstuffs which desirably replicate natural meat features, such as meaty flavor and aroma.

176. A POSITA would recognize Mottram’s relevance to the production of products such as meat replica matrices with “improved” meat-like characteristics such as a meaty aroma—specifically, a “beef-like” aroma. Mottram teaches that “over 1000” volatile compounds are associated with meaty aroma, and that a “larger number” of these compounds have been identified in beef than in other kinds of meat. EX1017(Mottram), 415. As discussed further below, Mottram identifies specific volatile compounds associated in the art with meaty aroma, particularly beef-like aroma. EX1017(Mottram), 418.

177. **Crane**, which is titled “Methods of Producing Recombinant Heme-Binding Proteins and Uses Thereof,” teaches methods for manufacturing high levels of fully iron-incorporated heme-proteins such as hemoglobin, myoglobin, and leghemoglobin using recombinant technology, which are “completely functional,” can be purified and are suitable for “commercial applications.” EX1014(Crane), Abstract, [0021], [0024], [0040], [0060]-[0062], [0085].

178. Such commercial applications include foodstuffs, as a POSITA would recognize recombinant technology usefulness for generating proteins for use in consumables. I previously submitted a declaration regarding the invalidity of U.S. Patent No. 10,863,761 (IPR No. 2022-00887 or “887 IPR”). In the 887 IPR, Motif’s expert Dr. Carl Batt opined that the POSITA of the ’761 patent would consider Crane analogous art for purposes of the obviousness inquiry for the ’761 patent. I agreed

with Dr. Batt and relied on his opinions in my analysis of that patent. I understand that Dr. Batt is offering the same opinion in this proceeding with respect to the '306 patent (for example, EX1007 Section VI).³ Based on my review of Crane, I agree with Dr. Batt that a POSITA seeking to modify a meat replica matrix (e.g., as taught in Conrad) would look to Crane, as it would have been within the general knowledge of a POSITA that recombinant technology could be useful for generating proteins for use in food products. As my personal expertise is not in genetic engineering, I rely on Dr. Batt's opinions regarding a POSITA's understanding of Crane's disclosure in my analysis in my Declaration.

179. Thus, each of the Conrad, Mottram, and Crane references are analogous art to the '306 patent, which relates to the desirability of making "improved" meat replica products that, due to "improved" meat-like properties, would appeal to a broader consumer base and motivate a shift away from the consumption of conventionally-sourced meat.

³ In the 887 IPR, the Crane reference was U.S. Patent No. 9,085,766. I understand that the present Crane reference is the "publication" of the application that issued as the Crane patent. Based on my review of the Crane patent and the Crane publication, their substantive disclosures are the same.

A. **Conrad, Mottram, and Crane Render Obvious Claims 1, 3–9, 11, 13–14, 16–21, 23–24, 26–27, and 29–33 of the '306 Patent**

180. As explained below, in my opinion, claims 1, 14, and 27 of the '306 patent are obvious.

1. **Claims 1[pre], 14[pre], 27[pre]**

181. The preamble is not limiting for reasons I explain further above (Section XI). Regardless, **Conrad** discloses these limitations. For example, limitation 1[pre] recites “[a] method for imparting a beef-like aroma to a meat replica matrix.”

182. **Conrad** teaches the preparation of meat replicas: “The present invention relates to *meat replacement products...*” EX1013(Conrad), 1:11-18, 1:21-40, 1:43-61, Table 1 (“Wheat meat” recipe); Table 2 (“Wheat meat CH” recipe”), Example 2 (“Preparation of a sausage...”); Example 3 (“Preparation of minced meat balls”).

183. Conrad teaches multiple advantages of its meat replacement products (EX1013(Conrad), 1:32-49), particularly financial and nutritional benefits:

It would be *desirable from a nutritional point of view and from a cost benefit point of view* to be able *to replace some of the meat* in minced meat products...with *a vegetable preferably cereal product*.

184. To this end, Conrad discloses methods of preparing “grain meat,” for example, “wheat meat” that is structured along with other components—including

conventionally-sourced meat—into products designed to resemble fully-meat products (e.g., sausage in Example 2 and meatballs in Example 3). EX1013(Conrad), 1:43-49 (below); Table 1 (“Wheat meat” recipe); Table 2 (“Wheat meat CH” recipe”).

These demands have now been solved surprisingly using a grain product, preferably a wheat product, which alone or in combination with blood products and/or milk protein products can form a grain or preferably a wheat meat, which can replace meat in minced meat products thereby allowing a nutritional change and a lowering of costs.

185. Conrad’s “grain meat”/“wheat meat” “can replace meat in minced meat[sp: meat] products.” EX1013(Conrad), 1:42-49.

186. Additionally, as I explain below for limitations [b]/[d], a POSITA would be motivated to combine Mottram with Conrad with a reasonable expectation of success, because Mottram teaches that incorporating the claimed sugars and sulfur-containing compounds produce volatiles associated with beef-like aroma upon cooking.

2. Claims 1[a], 14[a], 27[a]

187. Conrad discloses these limitations. For example, limitation 1[a] recites **“wherein the meat replica matrix comprises one or more plant proteins.”**

188. As explained below, **Conrad** discloses a “grain meat”—preferably “wheat meat”—replica used to replace at least some conventionally-sourced meat in

foodstuffs, and methods and advantages of making this product. EX1013(Conrad), 1:32-49 below.

It would be desirable from a nutritional point of view and from a cost benefit point of view to be able *to replace some of the meat* in minced meat products...with *a vegetable preferably cereal product*, whereby the amino acid composition of the final product can be varied and whereby the costs can be lowered compared with a pure meat product. These demands have now been solved surprisingly using *a grain product, preferably a wheat product*, which alone or *in combination with blood products* and/or milk protein products *can form a grain or preferably a wheat meat, which can replace meat* in minced meat products thereby allowing a nutritional change and a lowering of costs.

Wheat is a plant, as are the other grains (cereals). EX1001('306 Patent), 18:34-58 (“Non-limiting examples of plant sources include grain crops such as...wheat...”). “The grain meat... can be made of *corn (maize), barley, oat, and rye* as well...” EX1013(Conrad), 2:1-8. In particular, Conrad discloses that its meat replacement products comprise the grain protein “gluten” (EX1013(Conrad), 1:50-55):

The present invention...comprises the *gluten protein fraction*...from *whole cereal grain*. A preferred embodiment of the invention is characterized in that *the meat replacement product is gluten protein* and bran from *wheat*.

3. Claims 1[b], 14[b], 27[b]

189. The combination of Mottram and Conrad renders these limitations obvious. For example, limitation 1[b] recites “**a sugar selected from glucose, ribose, sucrose, fructose, xylose, maltodextrin, and combinations thereof, and at least one sulfur compound selected from methionine, cysteine and thiamine.**”

190. As a POSITA would recognize, and as reviewed by Dr. McGorin, the claimed sugars and sulfur compounds are Maillard reaction precursors long known to produce volatile compounds associated with meaty aromas when heated. EX1005 Section V. As an example of the many references in the literature on this subject, **Mottram** teaches that Maillard reactions between amino compounds and reducing sugars are “one of the most important routes to flavour compounds in cooked foods, including meat.” EX1017(Mottram), 416, 417, 422.

191. Mottram describes the results of flavor studies which found that **ribose**, which Mottram describes as “one of the main sugars” in muscle, and **cysteine** (an amino acid) play “an important role ... in meat flavour formation” when mixtures of the two compounds were heated. EX1017(Mottram), 416. Other flavor precursors include “free sugars,” “free amino acids,” and “**thiamine.**” EX1017(Mottram), 416.

192. As Dr. McGorin explains, these precursors have long been used in the art for the purpose of providing meaty flavor. EX1005 Section V.B. As taught in Mottram, for example, since the “classic patent” on this technology six decades ago

(1960), the industry has sought to patent “reaction product” meat flavorings based on these precursors. EX1017(Mottram), 416. As a POSITA would understand, such meat flavorings could be used to enhance the meaty flavors and aromas of a variety of foodstuffs.

193. Accordingly, a POSITA would be generally motivated to include Maillard precursors in a meat replica such as Conrad’s “grain/wheat meat” that is designed to replace at least part of real meat in a foodstuff in order to enhance its “meat-like” qualities and thereby appeal to consumers, and would reasonably expect success in doing so.

194. For example, a POSITA would be motivated to include the sugar ribose and the sulfur compound cysteine in Conrad’s meat replica, because Mottram teaches that these precursors are “particularly important for the characteristic aroma of meat.” EX1017(Mottram), 417; EX1005 Sections V.B, VI (discussing other sugar/sulfur compound combinations generating beef-like aroma). Conrad’s meat replacements are designed to replace at least part of real meat in a foodstuff, and a POSITA would be motivated to improve the replacement’s meaty flavor in order to enhance its “meat-like” qualities and thereby appeal to consumers by better creating the sensory experience of consuming real meat.

195. In particular, a POSITA would be motivated to include the sugar ***ribose*** and the sulfur compound ***cysteine***, which Mottram teaches are naturally present in

meat and are “particularly important for” generating “the characteristic aroma of meat” when meat is cooked.

The Maillard reaction is mainly responsible for the large number of heterocyclic compounds which have been found in the volatiles of cooked meat and are responsible for savoury, roast and boiled flavours. ***Pentoses, in particular ribose from meat ribonucleotides, and the sulfur-containing amino acid, cysteine, are important precursors for these reactions in meat.*** Furanthiols and furan sulfides and disulfides are very important flavour compounds, with exceptionally low odour threshold values, which are responsible for characteristic meaty aromas.

EX1017(Mottram), 422.

The Maillard reaction...between ***amino compounds*** and ***reducing sugars***...is one of the most important routes to flavour compounds in...meat.

EX1017(Mottram), 417.

[F]lavour precursors were suggested to be ***free sugars, sugar phosphates, nucleotide-bound sugars, free amino acids***, peptides, nucleotides, and ***other nitrogenous components, such as thiamine***....In muscle, ***ribose is one of the main sugars*** where it is associated with the ribonucleotides....Studies of the aromas produced on heating mixtures of amino acids and sugars, confirmed ***the important role played by cysteine and ribose in meat flavour formation*** and led to the classic patent...(1960) which involved ***the formation of a meat-like flavour by heating a mixture of these***

compounds. Most subsequent patent proposals for ‘reaction product’ meat flavourings have involved **sulfur, usually as cysteine** or **other sulfur-containing amino acids...**

EX1017(Mottram), 416.

196. A POSITA would also recognize benefits of combining Mottram’s sugar (e.g., ribose) and sulfur compound (e.g., cysteine) ingredients with Conrad’s “wheat meat” meat replica matrix because Conrad’s matrix is depleted of sugars and other components during its manufacture, with the result that Conrad’s replica might undesirably lack meaty, beef-like aroma. EX1013(Conrad), 2:1-46.

197. Specifically, **Conrad** discloses that, in manufacturing its “wheat meat,” sugars are removed when “[t]he grain meat...is separated into two main components,”—a “solid phase--grain meat”—as well as “a suspended aqueous phase” which comprises “sugars.” EX1013(Conrad), 2:1-8 (see below and Example 1).

The grain meat...is **separated into two main components, viz a solid phase--grain meat--and a suspended aqueous phase--starch granules containing** most of the water-soluble components of the grain such as soluble proteins, salts, and **sugars.**

The production of wheat meat encompasses...mechanical treatment and **separation of fractions.**

During the mechanical treatment, the *starch granules having a diameter of 0.003-0.03 mm are made free and are suspended in the water. The insoluble gluten protein fraction and the bran fraction form a solid mass.*

198. Thus, because a POSITA would recognize that Maillard precursors (e.g., sugars) are depleted from Conrad's products during preparation of the "grain meat" fraction, a POSITA would be motivated to add **Mottram's** precursors (e.g., cysteine/ribose) to Conrad's meat replicas in order to increase generation of volatile compounds associated with "beef-like" aroma, and would reasonably expect success based on these precursors' well-known role in creating meaty flavors and aromas, as explained above. Moreover, as explained further below concerning limitation [d], the art long taught that heating these precursors naturally produces volatiles that have been associated with meaty/beefy aroma, such as the character-impact compounds MFT and MFT-MFT. EX1005 Section VII.

4. Claims 1[c], 14[c], 27[c]

199. The combination of Conrad with Crane renders these limitations obvious. For example, limitation 1[c] recites "**the method comprising adding 0.01%-5% (by weight of the meat replica matrix) of a non-animal heme-containing protein to the meat replica matrix.**"

200. As I explain further below, the **Conrad** reference teaches a POSITA that adding up to 5% heme-protein (specifically, the blood-sourced protein

hemoglobin) by weight to Conrad's meat replacement product would contribute desirable meaty flavor and coloration in addition to other benefits.

201. Conrad discloses "grain meat" and "wheat meat" meat replica matrices that advantageously contain heme-protein (hemoglobin). In particular, Conrad teaches adding the "hemoglobin part" of slaughtered-animal blood to the grain-based "meat" confers multiple properties characteristic of meat: *first*, the color of the grain-based replica "***can advantageously be transferred into meat colour*** by adding thereto...blood," and *second*, the "***addition of blood/hemoglobin further gives a desired taste improvement as it improves the meat flavour of the final product.***" EX1013(Conrad), 4:3-17.

202. Conrad teaches levels of heme-protein in its meat replicas that achieve these desirable meat-like properties. Specifically, to achieve these goals, Conrad discloses utilizing the "***hemoglobin part*** of whole blood" in its grain-based "meat." EX1013(Conrad), 1:56-61, 4:5-10.

The wheat meat described has a brown-yellow colour deriving partly from the brown bran and partly from the yellow gluten. The colour can advantageously be transferred into meat colour by adding thereto up to 15% by weight of blood, preferably ***the hemoglobin part separated off from blood, the protein content of which is about 90% by weight and the dry substance contents are 33% by weight.***

It is to be noted that the dry substance contents of wheat meat are about 33 to 35% by weight and the addition of blood thus not changes the dry

substance. The addition of blood/hemoglobin further gives a desired taste improvement as it improves the meat flavour of the final product. (EX1013(Conrad), 4:3-17.)

203. Red blood cells are well-known to contain hemoglobin protein. (E.g., EX1139(Weed). The levels of hemoglobin in red blood cells are also long known in the art. As reproduced below, Tables 1 and 2 of Weed (1963) disclose proportions of hemoglobin and other components in the “dry weight” (non-water portion) of red blood cells (versus hemoglobin-depleted “ghost” cells).

TABLE I		
<i>Hemoglobin content per cell of red blood cells and ghosts</i>		
	Red blood cells (n =14)	Ghosts (n =24)
Hemoglobin, g $\times 10^{-12}$	30.99 $\pm$ 0.12 (SD)	0.015 $\pm$ 0.009 (SD)
Hemoglobin, % dry weight	97	1.4

TABLE II
*Lipid content per cell of intact red blood
cells and ghosts**

Lipids	Red blood cells	Ghosts	p
Total lipid, g $\times 10^{-12}$	4.91 $\pm$ 0.33	4.95 $\pm$ 0.33	> 0.60
Total cholesterol, g $\times 10^{-12}$	1.13 $\pm$ 0.08	1.08 $\pm$ 0.06	> 0.05
Total lipid phosphorus, μ g $\times 10^{-9}$	11.89 $\pm$ 0.68	11.47 $\pm$ 0.85	> 0.40
Individual phospholipids,† μ g P $\times 10^{-9}$			
Sphingomyelin	3.12 $\pm$ 0.14	2.91 $\pm$ 0.26	> 0.05
Lecithin	3.37 $\pm$ 0.19	3.28 $\pm$ 0.22	> 0.40
Phosphatidyl serine	1.79 $\pm$ 0.22	1.84 $\pm$ 0.09	> 0.40
Phosphatidyl ethanolamine	2.39 $\pm$ 0.26	2.31 $\pm$ 0.23	> .040
Other‡	1.22 $\pm$ 0.07	1.13 $\pm$ 0.07	> 0.40

* Mean values $\pm$ SD are given for preparations from nine hematologically normal subjects. p was determined by *t* test (20).

† Plasmalogens, where present, were analyzed with the parent compounds.

‡ This includes lysolecithin, inositol phosphatide, and polyglycerol phosphatide, which together constitute about 10% of the total lipid phosphorus of the red blood cell (11).

204. A POSITA would therefore understand Conrad's reference to the "hemoglobin part" of blood used in Conrad's "grain meat" / "wheat meat" products to mean **red blood cells**.

205. Consistent with this understanding, Conrad teaches that "the **dry substance contents** [of the "hemoglobin part"] are **33% by weight**." EX1013(Conrad), 4:5-10. I note that Conrad refers to "protein content" values before it refers to "dry substance" values, but a POSITA would understand that the 90% "protein content" value necessarily refers to the "dry substance" because the 66% (non-dry) remainder is water, which is not protein. In particular, a POSITA would understand that this "dry weight" portion of the "hemoglobin part" refers to

the components of the **red blood cells** that are **not water**—for example, proteins or lipids that may also be present in the cells.

206. Within this “dry weight” portion of Conrad’s “hemoglobin part,” Conrad teaches that its “the **protein content**” “is **about 90% by weight**.” EX1013(Conrad), 4:5-10. Although Conrad’s disclosure regarding the components of the “protein content” is not precise—for example, because Conrad does not teach particular methods for obtaining or purifying the “hemoglobin part” for use in its products—a POSITA would understand from the context of Conrad that Conrad teaches that the “**protein content**” of the “hemoglobin part” relates to **hemoglobin** itself—the protein known in the art to contribute to the desired meat-like flavor and color of Conrad’s products.

207. My interpretation of the “**protein content**” is reflected in Conrad’s choice of the term “**hemoglobin** part” to describe this fraction. My interpretation is also consistent with Conrad’s description of the components of this fraction in light of the art’s teaching of hemoglobin levels in red blood cells. Specifically, by using the term “**about**” to modify “90%,” for example, Conrad is identifying an **estimate of the levels of hemoglobin protein in the “dry weight” fraction of the “hemoglobin part.**” (Conrad does not define the scope of “about.”) In fact, the amount of hemoglobin could be different (and could potentially be higher than 90%, as taught in the art). EX1139(Weed), 584 (“**[H]emoglobin ... accounts for 97% of [a red**

blood] cell's dry weight'). A POSITA would understand that Conrad is merely providing an approximation of the amount of hemoglobin in the “dry” fraction of the “hemoglobin part.” Thus, when Conrad’s teachings are read together, a POSITA would understand that the “***about 90%***” *term refers to the proportion of hemoglobin protein in the “dry weight” fraction.*

208. My interpretation of Conrad is consistent with its description of its Table 2 meat replica embodiment—“Wheat Meat CH” (containing “Cheese fines” and “Hemoglobin” in addition to “Wheat Meat”), reproduced below:

TABLE 2				
Product	Amount in g	DS in %	Protein in DS %	Protein in g
Wheat meat	1,500	33	46	230
Cheese fines	500	33	85	140
Hemoglobin	100	33	90	30
Wheat meat <u>CH</u>	2,100	33	57	400

209. As shown in Table 2, Conrad teaches that only **30 grams** of the **100-gram** “Hemoglobin” component of the “Wheat Meat CH” embodiment are “protein.” In other words, the “Hemoglobin” in “Wheat Meat CH” is only comprised of 30% protein.

210. This proportion is consistent with the teachings of Conrad explained above. If “Hemoglobin” meant only hemoglobin *protein*, for example, the “protein” value would be 100 grams (100% of the total) rather than only 30 grams. Specifically, assuming that the 100-gram “Hemoglobin” in Table 2 refers to the

“hemoglobin part” added to the “wheat meat,” 33% of that “Hemoglobin” (“hemoglobin part”) is “dry weight.” Within that “dry weight” portion of “Hemoglobin,” about 90% of the “dry weight” is hemoglobin. This translates to approximately 30% grams of hemoglobin as shown below:

“Hemoglobin” (hemoglobin part)	“Dry Weight” portion of “Hemoglobin”	Heme-Protein (hemoglobin) portion of “Hemoglobin”
100 grams	(0.33 x 100 grams) = 33 grams	(0.9 x 33 grams) = 29.7 grams (about 30 grams)

211. The entire Table 2 “Wheat Meat CH” embodiment is 2100 grams. The percentage of hemoglobin in this whole product is therefore 29.7 grams (hemoglobin) divided by 2100 grams (product) (which equates to 0.01415 grams), multiplied by 100. Thus, the Table 2 Wheat Meat CH” embodiment of Conrad’s meat replacement products comprises approximately **1.43%** of the heme-protein hemoglobin. This value is within the claimed 0.01%-5.0% range of (“non-animal”) heme-containing protein.

212. Conrad teaches other embodiments with higher heme-protein concentrations than the Wheat Meat CH” embodiment. For example, Conrad teaches adding the “hemoglobin part” “up to 10% by weight *dry weight* of the gluten-bran product *dry weight*.” EX1013(Conrad), 1:56-61. This teaching calculates the “dry weight” of the “hemoglobin part” in the meat replica based on the “dry weight”

of the gluten/bran components in the replica. This teaching can be applied to

Conrad's Table 1 "wheat meat" embodiment. I reproduce Table 1 below.

TABLE 1

Compound	Meat		
	Beef	Swine	Wheat meat
Water	73%	65%	65%
Starch	0%	0%	3%
Bran-fiber	0%	0%	14%
Proteins	22	19%	15%
Fat	3%	12%	0%
Wheat germ incl. wheat germ oil	0%	0%	2.5%
Salts	2%	4%	0.5%
	100%	100%	100%

213. Table 1's "wheat meat" contains 65% water and 35% non-water (dry weight or "DW") components, respectively. I arrive at the 35% value of "dry" components by subtracting "65%" water (set forth in Table 1) from the total (100%).

214. Applying Conrad's teachings to Table 1's "wheat meat," adding the "hemoglobin part" contribute "up to 10%" of the "wheat meat" embodiment's dry components. EX1013(Conrad), 1:56-61. Because the embodiment is itself comprised of 35% dry components, multiplying the dry components (35%) by 10% (or 0.10) equates to 3.5% of the dry components contributed to the "wheat meat" from the "hemoglobin part."

215. Within the 3.5% of dry components contributed by the "hemoglobin part," "about 90%" is hemoglobin for reasons I explain above. Using the 90% value,

the amount of hemoglobin in the whole “wheat meat” embodiment of Table 1 represents **3.15%** of the total embodiment ($3.5\% \times 0.9$). I summarize this calculation below.

“Hemoglobin Part”’s DW Percentage of Wheat Meat DW	Bran/Gluten DW	DW contributed to Total “Wheat Meat” by “Hemoglobin Part”	Heme-Protein (hemoglobin) portion of “Hemoglobin Part” DW
10%	35% of total (65% is water)	$(0.10 \times 35\%) =$ 3.5%	$(0.9 \times 3.5\%) =$ 3.15%

216. Conrad also teaches that adding “**up to 15%** by weight of” the “wheat meat” using “preferably the hemoglobin part” of blood provides desirable meaty color. EX1013(Conrad), 4:5-10. Following the same principles, as summarized below, the “up to 15%” limitation represents about **4.5%** (by weight) heme-protein in Conrad’s “wheat meat.”

“Hemoglobin” (hemoglobin part) in Wheat Meat	“Dry Weight” portion of “Hemoglobin”	Heme-Protein (hemoglobin) portion of “Hemoglobin”
15%	$(0.33 \times 15\%) =$ 4.95%	$(0.9 \times 4.95\%) =$ 4.46% (about 4.5%)

217. As shown above, Conrad teaches “up to 10%” and “up to 15%” “hemoglobin part” (4.5% of the total product). EX1013(Conrad), 1:56-61, 4:5-10. Conrad does not teach a specific lower limit of this range and in fact teaches that

heme-protein is an optional component (i.e., a value of “0” on the range). EX1013(Conrad), 1:56-61 (describing adding the “hemoglobin part” as a “**preferred** embodiment”). Similarly, Conrad’s Abstract provides that “a blood hemoglobin fraction” “**can** be added” to Conrad’s meat replacements.

218. Additionally, a POSITA would understand that incorporating levels of heme-protein within the lower boundary of the claimed range could replicate proportions of heme-protein naturally present in various kinds of meat (see Section XII (Ground 1)). These levels could vary, because different kinds of meat have different compositions of nutrients, including heme-containing proteins.

219. For example, as taught in the Pearson treatise, percentages of myoglobin are different across meats and depending on the age of the slaughtered animal. EX1027(Pearson), 65 (teaching, e.g., “veal, 1 to 3 mg/g [0.1-0.3%]; beef, 4 to 10 mg/g [0.4-1.0%]; and old beef animals, 16 to 20 mg/g [1.6-2.0%]. Pork contains 1 to 3 mg/g for young animals...[0.1-0.3%]”). A POSITA would understand that it could be desirable to enhance the “meat-like” characteristics of Conrad’s meat replacements depending on the individual type of meat being replicated and the levels of heme-protein that naturally occur in that type of meat.

220. As an example, to the extent that a POSITA is motivated to create replacements for meats that naturally contain lower levels of myoglobin (such as veal or young pork), a POSITA would be motivated to incorporate heme-protein in

Conrad's meat replacement products at levels approaching the lower bound of the claimed heme-protein range (**0.01%-5%**) and reasonably expect success in doing so.

221. Thus, Conrad discloses or motivates a POSITA to add between 0.01%-5% heme-protein to replicas in order to achieve desirable meat-like properties. I note that the range taught in Conrad's embodiments—e.g., “up to 15%” of the hemoglobin part, or approximately 4.5% heme-protein—almost completely overlaps with the claimed range of (non-animal) heme-protein.

(a) Motivation to Combine with Crane

222. As I explain below POSITA would be motivated to substitute Conrad's blood-sourced hemoglobin with Crane's recombinantly-produced heme-proteins, with a reasonable expectation of success.

223. First, because a POSITA would be aware of general motivations in the art to reduce consumption of conventionally-sourced meat and animal products, a POSITA would be motivated to substitute Conrad's conventionally-obtained hemoglobin with heme-proteins from alternative sources. For example, obtaining blood from slaughtered animals incurs the same environmental consequences, expenses, and other potential ramifications as cultivating animals for meat (which I discuss above in Section VIII.A.2-4).

224. **Conrad** teaches or suggests this motivation, as Conrad teaches utilizing meat replicas in place of “animal meat.” EX1013(Conrad), 1:25-40 (“It is also known to replace some of the animal meat...”).

225. **Crane** also teaches or suggests this motivation, as Crane teaches using its recombinant heme-proteins in place of conventionally-sourced proteins. EX1014, [0062] (“Recombinant hemoglobin preparations are used as effective and safe oxygen carriers as an alternative to blood transfusion.”).

226. Second, **Conrad** teaches avoiding conventionally-sourced meat due to its relative expense, and it teaches preparing its products with the aim of lowering costs of manufacture. EX1013(Conrad), 1:25-40 (teaching that “**replac[ing]** some of the **animal meat tending to be somewhat expensive** with...protein rich vegetable product,” “would be **desirable...from a cost benefit point of view...**”).

227. **Crane** also provides a motivation to address financial considerations associated with conventionally-sourced animal products. Crane teaches that heme-proteins can be produced via a “**simple and inexpensive method**” which “is effective at producing fully incorporated heme proteins.” EX1014(Crane), [0085]; [0014] (“The present invention is a straightforward and **inexpensive method** for high fidelity incorporation of heme into recombinantly overexpressed heme proteins.”); [0043] (“**fungal** [expression] **systems are more efficient and economical...**”).

228. *Third*, Crane’s heme-proteins can be purified, which a POSITA would understand is generally desirable for a commercial application such as **Conrad’s** “grain meat” or “wheat meat” meat replacement product. EX1014(Crane), [0024], [0060]-[0062]; [0074] (disclosing His-tagged purification of heme-protein). In my experience, it is easier to prepare foodstuffs such as Conrad’s products using purified ingredients that are standardized. For example, Crane’s purification methods prevent the introduction of *undesired* components into the food products, such as cellular debris and materials from Crane’s expression system. Additionally, cellular materials from Crane’s expression system might affect stability—if they contain lipid or enzymes, for example, that could affect the food product or potentially the leghemoglobin itself. Thus, a POSITA would be motivated to utilize Crane’s purified heme-proteins instead of Conrad’s slaughtered-animal blood, with a reasonable expectation of success.

229. Indeed, Crane teaches that “[p]urified preparations of heme-binding proteins...have a variety of therapeutic, research, and commercial utilities”—which a POSITA would understand to include use in foodstuffs. EX1014(Crane), [0061]-[0062].

230. Crane teaches producing various heme-proteins, which include myoglobin, hemoglobin, and leghemoglobin. EX1014(Crane), [0021]:

In accordance with this aspect of the invention, a heme-binding protein encompasses any protein that contains a heme prosthetic group either covalently or noncovalently bound to itself. Heme-binding proteins have diverse biological functions including, oxygen transport, catalysis, active membrane transport, electron transport, and sensory. ***The various classes of heme-binding proteins that are encompassed by the methods of the present invention include, without limitation, globins (e.g., hemoglobin, myoglobin, neuroglobin, cytoglobin, leghemoglobin), cytochromes ... The recombinant heme-binding protein produced using the methods of the present invention can be prokaryotic or eukaryotic.*** ... In another embodiment of the present invention the recombinant heme-binding protein is bacterial. In yet another embodiment of the present invention, the recombinant heme binding protein is fungal, preferably yeast.

231. A POSITA would therefore reasonably expect success in obtaining recombinant heme-proteins such as leghemoglobin using the methods of Crane.

232. A POSITA would be motivated to utilize hemoglobin, myoglobin, or leghemoglobin in Conrad's products because, as explained further below, a POSITA would expect doing so to contribute (1) **desirable meat-like coloration**, (2) **desirable aroma/flavor**, and (3) **desirable meat-like nutrition**.

233. Color: A POSITA would understand that heme-proteins (e.g., myoglobin and hemoglobin) are "predominant" red pigments in animal muscle and denature when heated, causing meat's browning. EX1027(Pearson), 64;

EX1094(Suman), 82 (denaturation leads to “dull-brown” meat color).) As Crane’s recombinant hemoglobin and myoglobin are the same as those heme-proteins found in animal muscle, a POSITA would expect them to contribute to color in the same manner. Likewise, leghemoglobin is structurally similar to myoglobin and provides meat-like color to plants. EX1030(Garrocho-Villegas), 79 (leghemoglobin is “red pigment isolated from soybean root nodules”), EX1135(Nicola), 133; EX1133(Hargrove), 1032; *see also* my discussion below regarding claim 3.

234. Due to the close similarities in their structure (particularly with myoglobin), a POSITA would expect **Crane’s** recombinant leghemoglobin to achieve similar meat-like coloration in **Conrad’s** meat replacement products (“grain meat”) as myoglobin and hemoglobin achieve due to their presence in real meat.

235. Aroma: As Crane’s recombinant hemoglobin is the same as Conrad’s hemoglobin, a POSITA would expect it to contribute to flavor in the same manner. Leghemoglobin is structurally similar to hemoglobin and myoglobin—particularly myoglobin (Section VIII.B.3 above). EX1135(Nicola), (“Leghaemoglobins are plant haemoproteins which resemble animal myoglobins...”); EX1133(Hargrove), (“[T]ertiary folding patterns of...soybean Lb are very similar to those of mammalian myoglobins, and the α and β subunits of human hemoglobin...”). A POSITA would therefore expect leghemoglobin to contribute to flavor of **Conrad’s** meat

replacement products (“grain meat”) in the same manner as hemoglobin and myoglobin.

236. Nutrition: As I discuss further above (Background Section VIII.B.1), meat is an important dietary source of iron for many, and “haem [sp: heme] iron [is] more readily absorbed and utilised by the body” than other forms of iron. EX1029, 329. For example, the heme-protein myoglobin provides 95% of the iron in beef muscle. EX1027(Pearson), 64-65. Crane’s recombinant myoglobin, hemoglobin, and leghemoglobin are “fully incorporated” with heme iron. EX1014(Crane), [0080], [0084]-[0085]. A POSITA would therefore expect leghemoglobin to contribute to flavor of **Conrad’s** meat replacement products (“grain meat”) in the same manner as hemoglobin and myoglobin.

5. Claims 1[d], 14[d], 27[d]

237. The combination of Conrad and Mottram renders this limitation obvious. For example, limitation 1[d] recites “**wherein, upon cooking of the meat replica matrix, at least two volatile compounds are generated that are associated with a beef-like aroma, thereby imparting a beef-like aroma to the meat replica matrix.**”

238. **Conrad** teaches cooking its meat replica products. EX1013(Conrad), 5:35-50 (disclosing “comparative testing *frying*” of Conrad’s “wheat meat balls” in Example 3).

239. A POSITA would reasonably expect success in producing at least two volatile compounds associated with beef-like aroma when frying Conrad's products—which contain Mottram's sugar and sulfur compound precursors—because, as I explain further above with respect to limitation [b], as taught in **Mottram** and well-known to a POSITA, heat-reacting limitation [b]'s sugar/sulfur compounds produces at least two volatile compounds associated with beef-like aroma upon cooking of the meat replica matrix. The art long taught that when sugars and sulfur compounds are heated together, they will undergo the Maillard reaction to produce many volatile compounds associated with meaty aromas, including meat's character-impact compounds. EX1005 Sections V.A-B (reviewing EX1017, EX1032–1034, EX1038, EX1041, EX1045, EX1099, EX1129).

240. Mottram teaches these volatile compounds:

The characteristic flavour of cooked meat derives from thermally induced reactions occurring during heating, principally the Maillard reaction...leading to a wide range of products, which account for the large number of volatile compounds found in cooked meat. Heterocyclic compounds...are important flavour compounds produced in the Maillard reaction providing savoury, meaty, roast and boiled flavours.

EX1017(Mottram), Abstract.

The Maillard reaction, which occurs between amino compounds and reducing sugars, is one of the most important routes to flavour compounds in cooked foods, including meat. This reaction is complex and provides a large number of compounds which contribute to flavour...

EX1017(Mottram), 417.

It has been known for some time that furans and thiophenes...possess strong meat-like aromas and exceptionally low odour threshold values.... Gasser...identified ***2-methyl-3-furanthiol***[MFT] and the corresponding disulfide, ***bis-(2-methyl-3-furanyl) disulfide***[MFT-MFT], ***as major contributors to the meaty aroma of cooked beef.***

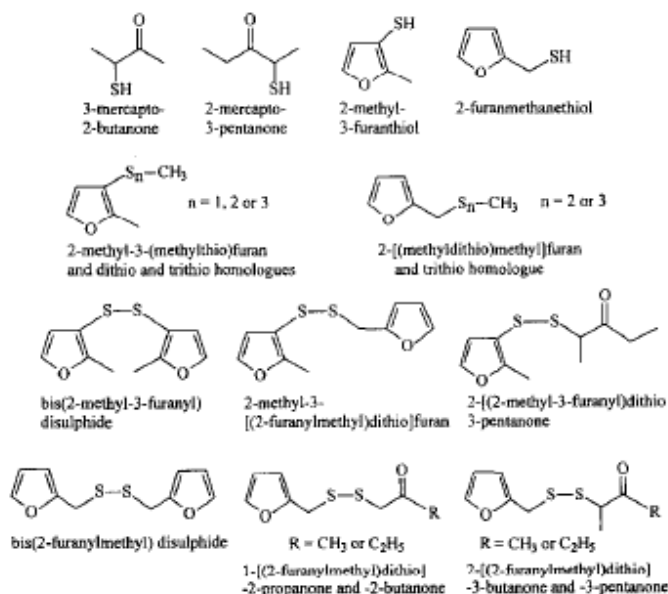
EX1017(Mottram), 418 (emphasis added).

Evaluation...indicated ***meaty characteristics for compounds containing 2-methyl-3-furanyl groups***...This is in agreement with earlier observations that ***furans with a thiol or sulfide group in the 3-position on the ring, possessed meaty odours...***

EX1017(Mottram), 418.

Furanthiols and furan sulfides and disulfides are very important flavour compounds...which are responsible for characteristic meaty aromas.

EX1017(Mottram), 422.



EX1017(Mottram), Figure 5 (“[T]hiols, sulfides and disulfides found in the volatiles of cooked meat”).

All cooked meats possess a desirable ‘meaty’ aroma and the identification of compounds with such characteristics has been the subject of a large amount of research, much of which has been driven by *the requirement for simulated meat flavourings for use in processed savoury food products*. It has been known for some time that *furans and thiophenes with a thiol group in the 3-position, and related disulfides, possess strong meat-like aromas and exceptionally low odour threshold values* MacLeod and Ames (1986) identified 2-methyl-3-(methylthio)furan in cooked beef. It has been reported to have a low odour threshold value (0.05 pg/kg) and a meaty aroma at levels below 1 pg/kg. Gasser and Grosch (1988) identified *2-methyl-3-furanthiol and the corresponding disulfide, bis-(2-methyl-3-furanyl) disulfide, as major contributors to the meaty aroma of cooked beef*.

(Mottram, 418 (EX1017).)

A comparison of boiled and roast beef shows that many more aliphatic thiols, sulfides and disulfides have been reported in boiled meat.

(Mottram, 417 (EX1017).) Mottram teaches additional volatiles associated with meaty aroma, as excerpted below.

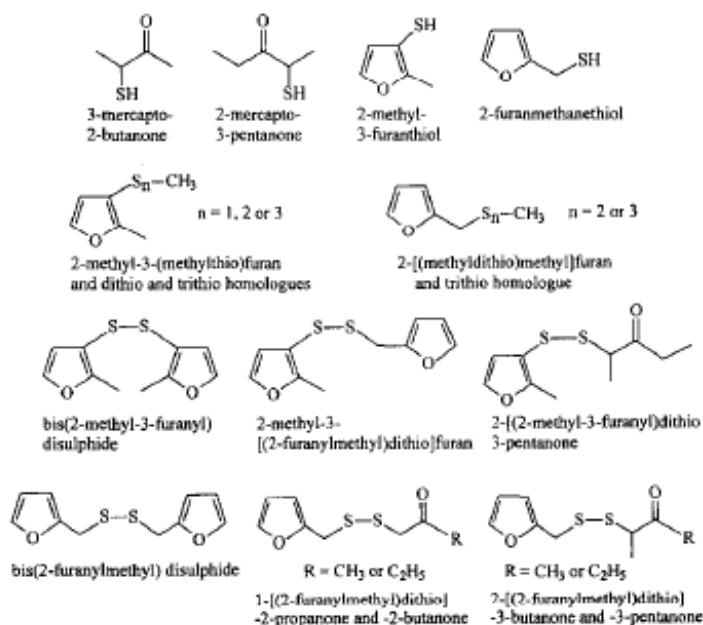


Fig. 5. Some thiols, sulfides and disulfides found in the volatiles of cooked meat (MacLeod and Ames, 1986; Gasser and Grosch, 1988; Farmer and Patterson, 1991; Madruga, 1994; Madruga and Mottram, 1995).

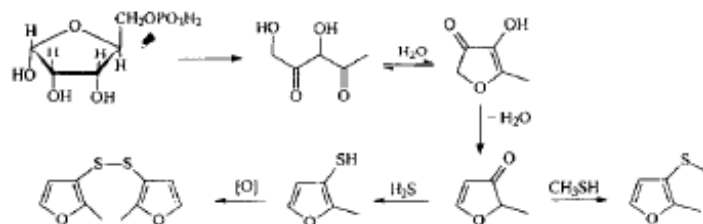


Fig. 6. Route for the formation of 2-methyl-3-furanthiol, bis(2-methyl-3-furanyl) disulfide and 2-methyl-3-(methylthio)furan from ribose phosphate (based on van den Ouweland and Peer, 1975).

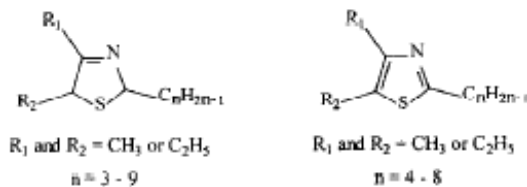


Fig. 7. Alkyl 3-thiazolines and thiazoles isolated from cooked beef (Elmore *et al.*, 1997).

241. Only ordinary skill would be required to prepare and assemble the individual components—e.g., **Mottram**’s sugar and sulfur precursors, and **Crane**’s purified recombinant hemoglobin—into **Conrad**’s meat substitute product and heat to generate at least two volatile compounds associated with beef-like aroma.

242. Conrad teaches conventional methods of mixing and heating ingredients for its “grain meat” replicas. EX1013(Conrad), 5:12-15 (“All raw materials are ground or cut together to a smooth paste...”). Conrad also teaches a method for manufacturing “wheat meat.” EX1013(Conrad), Example 1; *see also* 5:12-13 (“All raw materials are ground or cut together to a smooth paste...”).

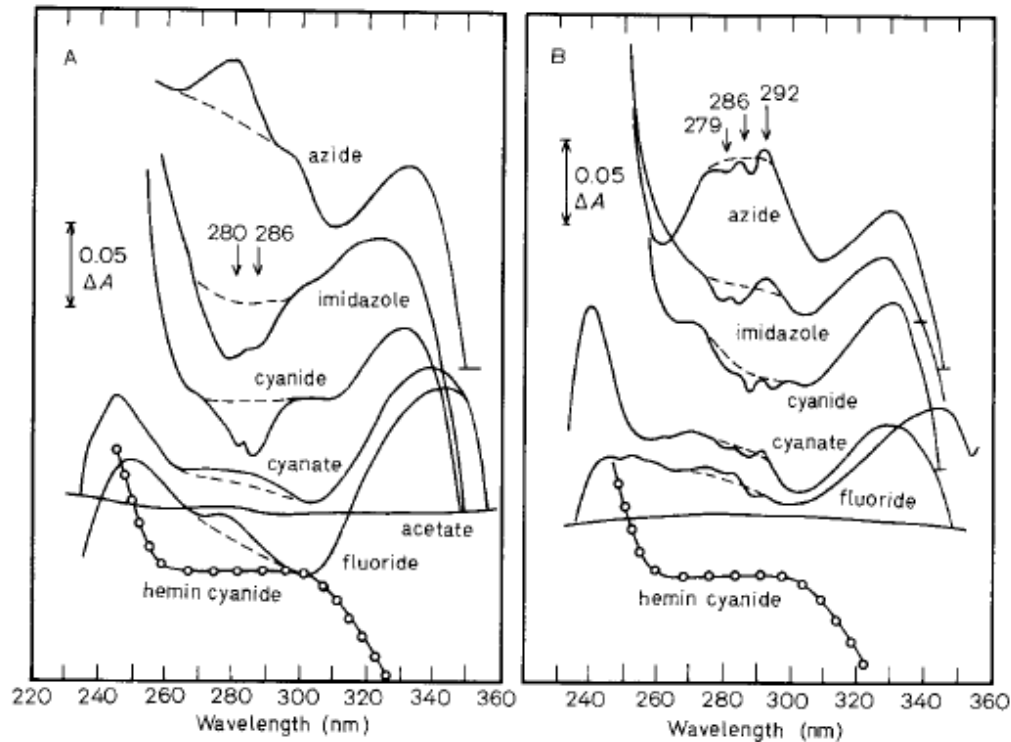
243. Moreover, a POSITA would reasonably expect success in imparting a beef-like aroma to Conrad’s meat replacement products as well-known Maillard reaction chemistry taught that specific precursor compounds—cysteine/ribose—generate volatiles associated with beef-like aroma when heated. EX1005(McGorin) ¶¶53, 112, §§, V, VII; EX1017(Mottram), 415-419.

6. Claims 3, 16, 29

244. In my opinion, claims 3, 16, and 29 are also obvious. E.g., claim 3 recites that **“the non-animal heme-containing protein has a UV-VIS spectrum that is substantially similar to that of myoglobin from an animal.”**

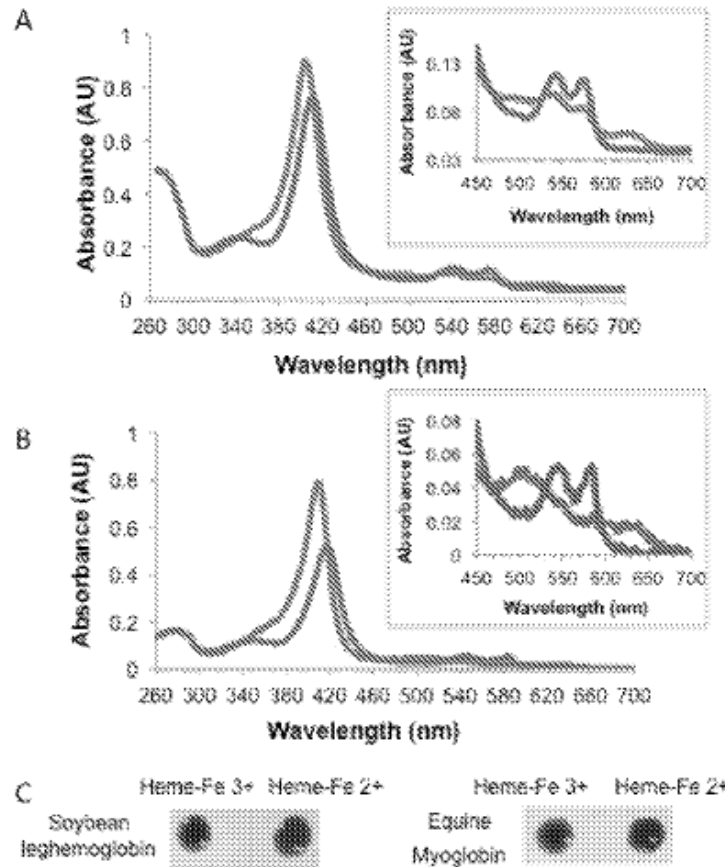
245. As explained above (claims 1, 14, 27), a POSITA would be motivated to use Crane’s recombinant leghemoglobin to replace blood-sourced hemoglobin in Conrad’s meat replica matrix (“grain/wheat meat”) as explained above. Crane’s recombinant myoglobin could also be used.

246. As a POSITA would understand, leghemoglobin’s UV-VIS spectrum (a reference to ultraviolet-visible spectroscopy) is substantially similar to that of animal myoglobin. The UV-VIS spectrum of Crane’s recombinant myoglobin would also be “substantially similar” to that of animal myoglobin—the same protein, differently sourced. The art taught that “[t]here is a high degree of structural homology between myoglobin and leghaemoglobin revealed by sequence alignments” and leghemoglobin “resemble[s] animal myoglobins with respect to their molecular weight, monomeric state” and other properties. EX1135 (Nicola), 133, 139. For example, Nicola and colleagues show the similarities in spectra between sperm whale ferric myoglobin and soybean ferric leghemoglobin when bound to a ligand (Figure 2):



247. Additionally, the three-dimensional structures of myoglobin and leghemoglobin are “very similar”—e.g., “[t]he tertiary folding patterns of lupin and soybean Lb[leghemoglobin] are very similar to those of mammalian myoglobins, and the α and β subunits of human hemoglobin.” EX1133, Hargrove, 1032.

248. Indeed, according to the Patent Owner’s research, leghemoglobin naturally “has a virtually identical absorbance spectrum and visual appearance to myoglobin from animal muscle.” EX1012, [00377]. I see that the Patent Owner demonstrated this natural property of leghemoglobin as reproduced below (EX1012, Fig. 5):



249. Accordingly, either Crane’s recombinant myoglobin or leghemoglobin has a UV-VIS spectrum that is substantially similar to that of myoglobin from an animal.

7. Claims 4, 17, 30

250. In my opinion, claims 4, 17, and 30 are also obvious. For example, claim 4 recites that “**heme-containing protein is selected from the group consisting of a leghemoglobin, a flavohemoglobin, Hell’s gate globin I, an erythrocrucorin, a protoglobin, a cyanoglobin, a chlorocrucorin, a truncated hemoglobin, a truncated 2/2 globin, and a hemoglobin.**”

251. As explained more fully above (claims 1, 14, 27), a POSITA would be motivated to replace Conrad's conventionally-sourced hemoglobin with **Crane's** leghemoglobin, with a reasonable expectation of success. For example, like that hemoglobin from slaughtered-animal blood that is used in Conrad's products, leghemoglobin has a red, meat-like pigment that would be desirable for coloring meat replica foodstuffs. EX1013(Conrad), 1:56-61; EX1030, 79.

252. A POSITA would reasonably expect success in achieving these claims because Crane teaches that a wide variety of heme-proteins, including the claimed heme-proteins, can be produced using its techniques. EX1014, [0021] (“[C]lasses of heme-binding proteins that are encompassed by the methods of the present invention include ... hemoglobin, ... The recombinant heme-binding protein produced using the methods of the present invention can be prokaryotic or eukaryotic.”).

253. A POSITA would also reasonably expect success because a variety of “non-animal” heme-proteins genetic sequences were available to a POSITA for use in Crane's methods. In particular, the genetic sequences of plant hemoglobins were known and available to a POSITA to be manufactured and obtained according to **Crane's** techniques. For example, according to a review of “six decades” of research on plant hemoglobins by Garrocho-Villegas, “Hbs [hemoglobins] are widespread in organisms, as *they have been identified in genomes of*

archaeobacteria, eubacteria and eukaryotes, including **plants**...” (EX1030, 78; also page 80 (“In addition to Lbs [leghemoglobins] and nsHbs [non-symbiotic hemoglobins], Hb [hemoglobin] **sequences** that are similar to those of microbial truncated (2/2) Hbs ... **were detected in primitive and evolved plants (Table 1)**”); page 81 (Table 1) (listing sequences).) Table 1 of Garrocho-Villegas is partially excerpted and reproduced below to represent examples of plant hemoglobin sequences known in the art and available to a POSITA:

Table 1
Hemoglobin sequences identified in land plants

Organism	Hb ^a (accession number ^b)		
<i>I. Seed plants</i>			
a) Angiosperms			
Monocotyledonous			
<i>Hordeum vulgare</i> (barley)	nsHb-1 (U94968), tHb (AF376063)		
<i>Oryza sativa</i> (rice)	nsHb1-1 (U76029), nsHb2-1 (U76031), nsHb3-1 (AF335504), nsHb4-1 (AF335504), tHb (BAD32857)		
<i>Saccharum</i> spp. (sugarcane)	nsHb-1 (C0373680)		
<i>Triticum aestivum</i> (wheat)	nsHb-1 (AY151390), tHb (AY151391)		
<i>Zea mays</i> ssp. <i>mays</i> (maize)	nsHb-1 (AY005818), nsHb-2 (DQ171946)		
<i>Z. mays</i> ssp. <i>parviglumis</i> (teosinte)	nsHb-1 (AF291052)		
Dicotyledonous (legumes)			
<i>Astragalus sinicus</i>	symHb (DQ199647)		
<i>Canavalia lineata</i> (bay bean)	symHb (UD9671)		
<i>Glycine max</i> (soybean)	symHb (V00453), nsHb-1 (U47143), tHb (AA548191)		
<i>Lotus japonicus</i>	symHb (AB238218), nsHb-1 (AB238220)		
<i>Lupinus luteus</i> (yellow lupine)	symHb (Y00401)		
<i>Phaseolus vulgaris</i> (kidney bean)	symHb (P02234)		
<i>Pisum sativum</i> (pea)	symHb (P02233)		
<i>Psophocarpus tetragonolobus</i> (winged bean)	symHb (X65874)		
<i>Medicago sativa</i> (alfalfa)	symHb (M32883), nsHb-1 (AF172172)		
<i>M. truncatula</i> (barrel medic)	symHb (X57733), tHb (ABE93362)		
<i>Sesbania rostrata</i>	symHb (M23313)		
<i>Vicia faba</i> (broad bean)	symHb (Z54159)		
<i>V. sativa</i> (common vetch)	symHb (Y00229)		
		<i>Vigna unguiculata</i> (cowpea)	symHb I (U33206), symHb II (U33207)
		Dicotyledonous (no-legumes)	
		<i>Alnus firma</i>	nsHb-1 (AB221344)
		<i>Arabidopsis thaliana</i>	nsHb-1 (NM_127165), nsHb-2 (NM_111887), tHb (NM_119421)
		<i>Beta vulgaris</i> (sugar beet)	nsHb-2 (BE590299)
		<i>Brassica napus</i> (canola)	nsHb-2 (AY026337)
		<i>Casuarina glauca</i> (swamp oak)	nsHb-2 (X77694), nsHb-1 (X53950)
		<i>Cichorium intybus</i> × <i>C. endivia</i> (chicory)	nsHb1-2 (CAA07547), nsHb2-2 (AJ277797)
		<i>Citrus unshiu</i> (satsuma orange)	nsHb-1 (AY026338)
		<i>Datisca glomerata</i> (durango root)	tHb (CAD33536)
		<i>Euryale ferox</i> (fox nut)	nsHb1-2 (AY281295), nsHb2-2 (AY281296)
		<i>Gossypium hirsutum</i> (cotton)	nsHb-1 (AY899302), nsHb-2 (AY026340)
		<i>Lycopersicon esculentum</i> (tomato)	nsHb-1 (AY026343), nsHb-2 (AY026344)
		<i>Malus domestica</i> (apple)	nsHb-1 (AY224132)
		<i>Myrica gale</i>	nsHb-1 (EF405885)
		<i>Nicotiana tabacum</i> (tobacco)	nsHb-1 (BQ842804)

8. Claims 5, 18, 31

254. In my opinion, claims 5, 18, and 31 are also obvious. For example, claim 5 recites **“incorporating into the meat replica matrix 0.4%-1% (by weight of the meat replica matrix) of the non-animal heme-containing protein.”**

255. As explained more fully above (claims 1, 14, 27), **Conrad** teaches advantages of incorporating between 0.01 and 5.0% of blood-sourced heme-protein in its “grain meat” meat replacement products, which a POSITA would be motivated to replace with **Crane**’s leghemoglobin with a reasonable expectation of success (for example, because Crane teaches methods of making and purifying leghemoglobin).

256. As discussed further above, the heme-protein range taught for Conrad’s products encompasses and overlaps with the claimed 0.4%-1% range of “non-animal” heme-containing protein.

257. Additionally, as discussed further above (claims 1, 14, 27), a POSITA would be motivated to incorporate a “non-animal” heme-protein such as leghemoglobin in meat replica products at levels that approximate the amounts of heme-protein that are naturally present in the type of meat being replicated. The art taught, for example, the desirability of recreating the nutrient profile of meat in meat replicas intended to appeal to a broad swath of consumers (including those who choose to consume “real” meat). E.g., EX1021, [0100] (“The ***nutrients added to the***

ground meat and simulated meat are provided to create a product with a nutrient composition comparable to animal meat products.”).

258. For example, because certain kinds of beef muscle naturally contain myoglobin in ranges that span between approximately 0.4% and 1.0% (EX1027, 65), a POSITA seeking to replicate real beef using a Conrad “grain meat” meat replacement product would be motivated to incorporate between approximately 0.4 and 1.0% by weight of “non-animal” heme-protein (e.g., leghemoglobin) in the Conrad product. A POSITA would reasonably expect success in doing so at least because, as I discuss above, leghemoglobin possesses similar structural, coloration, and nutritive properties as myoglobin.

9. Claims 6, 24

259. In my opinion, claims 6 and 24 are also obvious. For example, claim 6 recites that “**the non-animal heme-containing protein is purified.**”

260. As explained above (claims 1, 14), a POSITA would be generally motivated to purify heme-proteins for use in a foodstuff such as **Conrad’s** meat replacement products.

261. A POSITA would reasonably expect success in doing so, for example, because **Crane** teaches methods of producing purified heme-protein preparations by separating heme-proteins from other components of Crane’s expression systems, e.g., via cleavable “tags” attached to the protein when it is initially expressed.

EX1014, [0060]-[0062]; *see also id.* [0074] (“The...plasmid allows over-expression of gsNOS [heme-protein] with a cleavable His-tag...GsNOS was expressed and purified....”). Crane teaches that, for example, “[i]n a preferred embodiment of the present invention, the purified preparation of functional recombinant heme binding protein is prepared in accordance with the methods described *supra*.” EX1014, [0061]. In one specific example of Crane’s method, Crane discloses that its heme-proteins “were ***purified to >95% purity*** using size exclusion chromatography after the removal of” a His-tag (“6xHis”). EX1014, [0075].

262. Accordingly, the proteins that can be purified by Crane’s purification methods include “non-animal” heme-proteins such as leghemoglobin. EX1014, [0021] (also discussing other kinds of non-animal heme-proteins, such as “prokaryotic” heme-proteins).

10. Claims 7, 19

263. In my opinion, claims 7 and 19 are also obvious. For example, claim 7 recites that “**at least one of the one or more plant proteins is isolated.**”

264. Based on my review of the ’306 patent, it does not provide a specific definition of the term “isolated,” including with respect to a specific protein. I note that a related term, “isolated and purified,” is described as follows:

“Isolated and purified protein” refers to a preparation in which the ***cumulative abundance by mass of protein components other than the specified protein***, which can be a single monomeric or multimeric

protein species, *is reduced by a factor of 2 or more*, 3 or more, 5 or more, 10 or more, 20 or more, 50 or more, 100 or more or 1000 or more *relative to the source material from which the specified protein was isolated*. For clarity, the isolated and purified protein is described as isolated and purified relative to its starting material (e.g., plants or other non-animal sources).

EX1001, 17:33-51. The patent also provides that “[t]he isolated and purified proteins can be isolated from one or more other components of a non-animal source. For example, a protein fraction may be isolated from an isolate of a plant.” EX1001, 20:32-37.

265. Thus, it is my understanding that no particular level of purity is required for an “isolated” protein. “In *some embodiments*, the term “isolated and purified” *can indicate* that the preparation of the protein is at least 60% pure, e.g., greater than 65%, 70%, 75%, 80%, 85%, 90%, 95%, or 99% pure.” EX1001, 17:44-47. I understand the term “some” embodiments to mean that “*not all*” embodiments have the specified purity.

266. As explained above (claims 1, 14), **Conrad** discloses conventional methods of isolating (e.g., separating) plant proteins from other plant components such as the whole grain. For example, Conrad’s “grain meat” “comprises *the gluten protein fraction* and the bran fraction *from whole cereal grain* [a plant source],” EX1013(Conrad), 1:50–52, which is “is prepared from the whole grain which after crushing *is separated* into two main components...” EX1013(Conrad), 2:1-6, 2:24-

28, 2:66–3:2 (“The insoluble gluten protein fraction and the bran fraction form a solid mass. The slurry **is separated** by sieving on a sieve...”). This approach separates the gluten protein from other components of the whole grain, including sugars and “soluble proteins” (below, EX1013(Conrad), 2:1-4). Conrad does not expressly teach the level of purity of the resulting isolated plant protein (e.g., gluten in the gluten fraction).

The grain meat, preferably wheat meat, although it can be made of corn (maize), barley, oat, and rye as well, is prepared from the whole grain which after crushing **is separated into two main components**, viz a **solid phase-grain meat**-and **a suspended aqueous phase-starch granules containing most of the water-soluble components of the grain such as soluble proteins, salts, and sugars**.

267. Although not expressly taught in Conrad, a POSITA would be generally motivated to isolate proteins for use in a foodstuff. As I explain above, doing so (using well-known and conventional techniques) would desirably eliminate components of the source material such as fats that might oxidize and contribute to off-flavors or reduced shelf life. I discuss this further below in Ground 5 (Section XV1). Because protein isolation and purification techniques were known in the art (as discussed below with respect to the Cho reference), a POSITA would reasonably expect success achieving this claim.

11. Claims 8, 20

268. In my opinion, claims 8 and 20 are also obvious. For example, claim 8 recites that “**at least one of the one or more isolated plant proteins is purified.**”

269. As explained further above regarding Ground 1 and also claims 7 and 19 above, the '306 patent does not provide a specific definition of “purified,” including with respect to a specific protein (or isolated protein). EX1001, 20:35-37 (“The isolated proteins may in some cases be purified, wherein a certain kind of protein is *separated from other components found in the non-animal source.*”). However, as the plain language of the claims provide, an “isolated” protein can *also* be “purified,” indicating a further degree of separation of the protein compared to its source materials.

270. As explained above (claims 7 and 19), although Conrad’s “gluten fraction” is isolated from other components of the whole grain, Conrad does not expressly teach the level of purity of the gluten plant protein in its “grain meat” (e.g., gluten in the gluten fraction). However, the gluten has been “purified” in that it is separated from other components found in the soybean.

271. Moreover, although not expressly taught in Conrad, a POSITA would be generally motivated to further purify isolated proteins for use in a foodstuff such as Conrad’s “grain meat.” Doing so (using well-known and conventional techniques) would desirably eliminate components of the source material such as

fats that might oxidize and contribute to off-flavors. I discuss this further below in Ground 5, in which the art provides examples of techniques to purify protein isolates (soy protein isolates) to eliminate unwanted flavors; thus, a POSITA would reasonably expect success achieving this claim.

12. Claims 9, 21, 32

272. In my opinion, claims 9, 21, and 32 are also obvious. For example, claim 9 recites that “**the one or more plant proteins are selected from the group consisting of rubisco, pea proteins, lentil proteins, and other legume proteins.**”

273. As explained above (claims 1, 14, 27), **Conrad** teaches or suggests that legume proteins, such as soybean proteins, can be used in its meat replica matrices. Conrad teaches, for example, that “*[i]t is also known to replace some of the animal meat tending to be somewhat expensive with soybean meal which is a protein rich vegetable product.*” EX1013(Conrad), 1:25-27. A POSITA would reasonably expect that combining heme-protein with soybean protein would achieve the same desired meaty flavor and coloration benefits taught for Conrad’s “grain/wheat meat.”

13. Claims 11, 23

274. In my opinion, claims 11 and 23 are also obvious. For example, claim 9 recites that “**the one or more plant proteins are present in the meat replica matrix in an amount of between 1% and 30% (by weight of the meat replica matrix).**”

275. As discussed further above, **Conrad** provides an exemplary recipe for “wheat meat” containing 15% plant protein (within the claimed 1-30% range of protein “by weight” of the “wheat meat” meat replica):

The compositions of [beef and swine meat] in comparison with the wheat meat of the invention are given below.

TABLE 1			
Compound	Meat		
	Beef	Swine	Wheat meat
Water	73%	65%	65%
Starch	0%	0%	3%
Bran-fiber	0%	0%	14%
Proteins	22	19%	15%
Fat	3%	12%	0%
Wheat germ incl. wheat germ oil	0%	0%	2.5%
Salts	2%	4%	0.5%
	100%	100%	100%

EX1013(Conrad), 3:50-67, highlighting added.

276. Conrad teaches “adding thereto up to 15% by weight of blood.” EX1013(Conrad), 4:3–10. A POSITA would recognize that this addition (of the “hemoglobin part” containing heme-protein) could proportionally dilute plant proteins down to 85% of the levels disclosed for Table 1’s “wheat meat”—i.e., to 12.75%. Even so, the levels of plant protein in the replica remain within the claimed range of 1–30%.

14. Claims 13, 26, 33

277. In my opinion, claims 13, 26, and 33 are also obvious. The combination of **Conrad** and Mottram teaches or suggests these limitations, which naturally result

from heating a consumable containing Conrad's meat replicas containing Mottram's sugar and sulfur compounds (e.g., cysteine and ribose). For example, limitation 13 recites that **“the meat replica matrix is comprised within a consumable product, wherein the consumable product is selected from taco filling, a casserole, a sauce, a topping, soup, stew, and a loaf, wherein, upon cooking of the consumable product, the at least two volatile compounds are generated in substantially higher amounts than upon cooking of the consumable product lacking the meat replica matrix.”**

278. As discussed further above with respect to claims 1, 14, and 27, Conrad teaches (for example) a sausage replica sandwich “topping” as well as “meat balls.” EX1013(Conrad), 4:51-52; Example 2 (“Preparation of sausage to be... used **on top of** a sandwich”); Example 3 (“Preparation of minced meat balls”).) A POSITA would understand Conrad's meat replicas could replace conventionally-sourced meat equivalents in various consumables and compositions.

279. For example, Conrad's sausage or meatball (Example 3) replicas could be used in a variety of the recited consumable products to replace conventionally sourced meat equivalents such as, for example, in spaghetti **sauce**, as a **topping** for spaghetti, or in **soups** that traditionally contain meatballs (e.g., Italian wedding soup).

280. These claims cover two forms of consumable products: (1) consumables and meat replica compositions that contain a meat replica matrix, and (2) consumables/compositions “lacking the replica matrix.” As taught or suggested in Conrad, e.g., an example of the former could be “meatballs” in spaghetti sauce. The latter consumable would be the sauce alone.

281. As I discuss further above (Section XII.A.5), cooking the former consumable (e.g., sauce containing “meatballs” modified with the sugar ribose and the sulfur compound cysteine, as taught in Mottram) generates at least two volatile compounds associated with beef-like aroma. But the latter consumable—“the consumable product lacking the meat replica matrix”—might not contain Maillard precursors and thus not generate meaty aroma-associated volatiles when cooked.

282. However, even if the latter consumable (e.g., sauce alone) did generate volatile compounds associated with beef-like aroma when cooked, a POSITA would expect that combining Conrad’s meat replica with the latter consumable would thereby naturally produce “substantially higher” amounts of the claimed volatiles than if the replica were *not* included in the sauce.

283. In other words, the volatiles produced from the **Conrad** replica (containing Maillard reaction precursors) would be *added to* any volatiles produced by “the consumable product lacking the meat replica matrix,” and would therefore necessarily be present in “substantially higher” amounts than the volatiles produced

by cooking the “consumable product lacking the meat replica matrix” by itself—i.e., “the consumable product lacking the meat replica matrix.”

XIII. GROUND 2: CONRAD, MOTTRAM, PROULX

284. In my opinion, claims 1, 3–9, 11, 13–14, 16–21, 23–24, 26–27, 29–33 of the ’306 patent are obvious over Conrad in view of Mottram and Proulx.

285. Like Conrad and Mottram, **Proulx** is analogous art because, as discussed further below, Proulx teaches motivations and methods to improve plant-based foodstuffs in order to achieve nutritional benefits without requiring the use of real, conventionally sourced meat—a common source of dietary iron among other nutrients. In particular, as recognized by the ’306 patent Examiner, Proulx provides a motivation to fortify plant-based foodstuffs with heme iron via leghemoglobin sourced from soybean plants. I discuss the Examiner’s consideration of the Proulx reference further above (Section VI.C). Proulx is therefore in the same field of endeavor as the ’306 patent and reasonably pertinent to the problem facing that patent’s name inventors.

286. Proulx teaches that, for example, “[h]eme iron in the human diet is generally present in animal sources as a part of hemoglobin and myoglobin but is also found in” plant sources; however, plant heme-proteins “currently do not provide a significant amount of iron in human diets.” EX1019, 1518. Recognizing that “incorporation of animal-sourced heme iron is often unfeasible because of economic

costs or because [of] cultural and religious barriers” (EX1019, 1521), Proulx teaches advantages of “use of plant hemoglobins for improving ... human diet,” particularly leghemoglobin sourced from soybean plants (specifically, soybean root nodules). EX1019, 1518; 1521.

A. Conrad, Mottram, and Proulx Render Obvious Claims 1, 3–9, 11, 13–14, 16–21, 23–24, 26–27, and 29–33

287. As explained below, in my opinion, claims 1, 14, and 27 of the ’306 patent are obvious.

1. Claims 1[pre]-[b], 1[d], 14[pre]-[b], 14[d], 27[pre]-[b], 27[d]

288. Conrad and Mottram disclose and render these limitations obvious for reasons I explain further above in Ground 1 (Section XII.A).

2. Claims 1[c], 14[c], 27[c]

289. As a POSITA would recognize, Proulx’s plant-sourced leghemoglobin is the same leghemoglobin protein (e.g., the same amino acid sequence) that can be otherwise produced, purified, and obtained using Crane’s recombinant expression techniques and methods. A POSITA would therefore be motivated to combine Proulx’s leghemoglobin with Conrad and Mottram for the same reasons set forth in Ground 1 with respect to the Crane reference, with a reasonable expectation of success.

290. In particular, a POSITA would recognize that Proulx’s soybean-sourced leghemoglobin would contribute the same desirable aroma/flavor, meat-like

coloration, and nutrition to Conrad's grain meat as Crane's recombinantly-produced leghemoglobin. (Section XII.A above.)

291. **Proulx** teaches additional motivations to combine its leghemoglobin with plant-based foodstuffs such as Conrad's "grain meat." Proulx's underlying objective "is to introduce the concept of using plant hemoglobin as a heme iron source in" human diets, and it shows leghemoglobin has "great potential to be used as a fortificant for improving nutrition." EX1019, 1518, 1522.

292. Specifically, Proulx teaches that "[h]eme iron bioavailability has long been known to have higher bioavailability ... than nonheme iron." EX1019, 1520. As taught in Proulx, soybean-sourced leghemoglobin "showed similar bioavailability" to bovine hemoglobin in a food matrix. *See, e.g.*, EX1019, Abstract, 1518, 1520, 1521 ("Our results showing the bioavailability of hemoglobin from soy root nodules similar to that of heme iron from animal sources when added with tortillas provide a unique alternative fortificant, hence to improve the iron status of the population.").

293. It is my understanding that the Patent Owner (Impossible Foods) agrees with me on this point. In its "generally recognized as safe" (GRAS) submission to the FDA for soy leghemoglobin, for example, the Patent Owner noted that bioavailability of iron in soy leghemoglobin is equivalent to that of bovine myoglobin when in a food-like substrate. EX1052, 7 (citing EX1019).

2.3.2 Purposes

The primary purpose of the characterizing component, soy leghemoglobin protein, in LegH Prep is to create a flavor impact in ground beef analogue products. In addition, soy leghemoglobin has a nutritive value as a source of iron, analogous to the role of myoglobin as an iron source in meat. Once cooked and digested, both soy leghemoglobin and animal-based myoglobin release identical heme B molecules into the digestive system (Annex 1). Studies using cell models of iron bioavailability have shown that the bioavailability of iron in soy leghemoglobin is equivalent to that of bovine myoglobin when in a food-like substrate (Proulx & Reddy, 2006). Thus, the use of LegH Prep in ground beef analogue products will enhance both the flavor and the dietary profile of those products (Carpenter & Mahoney, 1992).

EX1052, (GRAS submission), 7.

294. A POSITA would also have been motivated to fortify Conrad's "grain meat" with leghemoglobin because Proulx teaches the "high heat stability of ... [heme] iron" compared to non-heme iron (EX1019, 1520, 1522), which a POSITA would recognize as advantageous in heated (cooked) foodstuffs.

295. Proulx additionally teaches economic advantages of utilizing soybean leghemoglobin. Specifically, Proulx acknowledges that "[s]oy root nodules have no current use in agriculture production and as such may provide a novel value-added product for soy producers." EX1019, 1522.

296. In view of the foregoing, a POSITA would have been motivated to add purified soy leghemoglobin as taught by Proulx into Conrad's meat placement products (e.g., Conrad's "grain meat") in order to fortify those compositions with heme iron as well as provide other benefits, particularly meaty flavor and color contributed by hemoglobin as taught in Conrad. Doing so would mimic the

nutritional profile (and specifically, the heme iron content) of conventionally-sourced beef in Conrad's replicas.

297. My views are also consistent with those of the '306 patent Examiner, who observed that (July 2016 rejection), with respect to a prior art meat analog (Hseih):

since Proulx et al. teach that heme iron in the human diet is generally present in animal sources as a part of hemoglobin and myoglobin and since Proulx et al. teach the use of heme iron from plant sources as a food fortificant, ***one of ordinary skill in the art would have been motivated to try fortifying the structured plant protein product (i.e. meat analog) of Hseih et al.*** [or the meat substitute product of Brackenridge] ***as taught by Proulx et al.***

Here, the motivation to combine the references comes from Proulx et al. Proulx et al. teach that iron deficiency is a major nutritional problem and fortification of foods with iron has been a successful strategy for improving iron content of foods (p. 1518/Introduction). Proulx et al. teach that iron bioavailability is higher from heme iron sources because of lack of inhibition from chelating compounds (p. 1518/Introduction). Proulx et al. teach that heme iron in the human diet is almost exclusively from animal sources and its intake has been shown to have a positive correlation with iron status (p. 1520/Results and Discussion). Proulx et al. teach that the incorporation of animal sourced heme iron is often unfeasible because of economic costs and because cultural and

religious barrier forbid the consumption of meat (p. 1520-1521/Results and Discussion).

(EX1148, 2131.)

298. A POSITA would reasonably expect success in substituting Proulx's leghemoglobin in Conrad's wheat meat. As discussed above (Ground 1), only ordinary skill would be needed to prepare Conrad's meat replacement product using methods taught in Conrad.

299. Additionally, **Proulx** teaches conventional methods for obtaining soybean leghemoglobin for use in foodstuffs, which would require only ordinary skill to practice. For example, Proulx teaches conventional methods for extracting leghemoglobin from soybean root nodules, in which leghemoglobin is isolated from other components of the root nodules. Proulx further teaches purifying leghemoglobin (e.g., using chromatography-based separation) for subsequent use in a food product:

The root nodules were mechanically harvested . . . removed from root structures, and lyophilized. Dried nodules were ground to pass a 30 mesh screen. Crude SRN fraction was prepared by reconstitution of dried nodule powder with water 1:5 w/w, followed by centrifugation (5000g for 30 min). Supernatant was collected, lyophilized, and stored at -20 °C until use. The aqueous extract was also used to prepare partially purified LHb (referred to as LHbA) by using 50-80% ammonium sulfate ((NH₄)₂- SO₄) precipitation, followed by desalting by dialysis with water. The desalted protein extract was lyophilized and

stored at -20 °C for further use. Ion exchange chromatography with DEAE Sepharose (GE Healthcare, Piscataway, NJ) was used to further purify the LHb obtained from (NH₄)₂SO₄ precipitation. The column was equilibrated to pH 7.0 and ran with a linear gradient elution starting with deionized (DI) water and ending with 1 mol/L NaCl at pH 7.0. Eluants that were in the 405 nm absorbance peak were pooled, desalted by dialysis, and lyophilized (referred to as LHbD).

300. Like Conrad, Proulx teaches conventional methods of mixing its leghemoglobin with other ingredients to produce a fortified foodstuff (tortillas). As explained on page 1519 of Proulx:

Tortilla Preparation. Unfortified masa harina (Ultrawhite #1 tortilla flour, Cargill Foods, Paris, IL) was fortified with 50 ppm iron with one of the following: SRN, LHbA, BHb (98% pure, Sigma Aldrich, St. Louis, MO) or ferrous sulfate (FeSO₄) (Sigma Aldrich). Masa harina (200 g) was mixed with fortificants, sealed in a plastic container, and thoroughly mixed by shaking 2 min. Masa harina was reconstituted with DI water (1:2 w/w), weighed to 25 g portions, flattened by tortilla press, and fried at 200 °C on a Teflon pan, 2 min on each side.

301. For reasons provided in greater detail above in Ground 1, for example, a POSITA would therefore reasonably expect success in modifying Conrad's meat replacement product with Proulx's soybean-sourced leghemoglobin to achieve the claimed 0.1%-5% percentage of "non-animal" heme-protein.

3. Claims 3, 16, 29

302. In my opinion, claims 3, 16, and 29 are also obvious. E.g., claim 3 recites that **“the non-animal heme-containing protein has a UV-VIS spectrum that is substantially similar to that of myoglobin from an animal.”**

303. A POSITA would understand that **Proulx’s leghemoglobin** meets this limitation. As a POSITA would understand, Proulx’s soybean-sourced leghemoglobin refers to the *same* protein as leghemoglobin—for example, the same amino acid sequence—produced via Crane’s recombinant techniques, but obtained from plants. Accordingly, a POSITA would understand that the UV-VIS spectrum of Proulx’s leghemoglobin is “substantially similar” to that of myoglobin from an animal for the same reasons explained above for Crane’s recombinantly-produced leghemoglobin.

304. Additionally, as disclosed in the Brown reference and discussed further above (Section XII.A.6), the Patent Owner has acknowledged that leghemoglobin naturally “has a virtually identical absorbance spectrum and visual appearance to myoglobin from animal muscle.” EX1012, [00377] & Figure 5. Thus, it is my opinion that these claims are obvious.

4. Claims 4, 17, 30

305. In my opinion, claims 4, 17, and 30 are also obvious. For example, claim 4 recites that **“heme-containing protein is selected from the group**

consisting of a leghemoglobin, a flavohemoglobin, Hell's gate globin I, an erythrocrucorin, a protoglobin, a cyanoglobin, a chlorocrucorin, a truncated hemoglobin, a truncated 2/2 globin, and a hemoglobin.”

306. As explained above for claim 1, 14, and 27, a POSITA would be motivated to utilize a heme-protein such as **Proulx's** soybean-sourced leghemoglobin in **Conrad's** meat replacement products (e.g., “grain meat”/ “wheat meat”) with a reasonable expectation of success. Accordingly, it is my opinion that these claims are obvious.

5. Claims 6, 24

307. In my opinion, claims 6 and 24 are also obvious. For example, claim 6 recites that “**the non-animal heme-containing protein is purified.**”

308. As discussed further above for claim 1, 14, and 27, Proulx teaches purifying its soybean leghemoglobin. EX1019, 1518 (“The objective of this study was to determine the iron bioavailability of...two purified soy leghemoglobins...”), 1519 (“*Ion exchange chromatography...was used to further purify the LHb* obtained from (NH₄)₂SO₄ precipitation.”). See *supra* claims 1, 14, 27.

6. Claims 5, 7–9, 11, 13, 18–20, 21, 23, 26, 31–33

309. For reasons I explain above (Ground 1), Conrad and Mottram render these claims obvious.

XIV. GROUND 3: ROVAART, CONRAD, CRANE

310. In my opinion, claims 1, 3–9, 11, 13–14, 16–21, 23–24, 26–27, 29–33 of the '306 patent are obvious over Rovaart in view of Conrad and Crane. A POSITA would be motivated to combine the teachings of these references to arrive at the claimed subject matter (and have a reasonable expectation of success at doing so) for reasons that I explain further below.

A. Rovaart Is Analogous Art to the '306 Patent

311. The Conrad and Crane references are analogous art to the '306 patent for reasons I explain above (Section XII of this Declaration). The Rovaart reference is also analogous art, in my opinion.

312. **Rovaart**, which is titled “In situ *production of meat like flavor in expanded porous food product*,” is analogous art to the '306 patent because it describes the “the preparation of porous expanded food products having a meat-like taste.” (EX1125, 1:5-7; Abstract (disclosing obtaining “*meat analogues* when the mixture has a high protein content”).) According to Rovaart, these products can be prepared from plant sources, and can have meat-like properties including simulated meat texture:

Food products with a porous expanded structure, such as crisp snacks or *products simulating the texture of meat*, are generally prepared from *flour or meal of vegetable origin* rich in carbohydrates, or from *substances rich in protein of plant*, animal or microbial *origin*.

(EX1125, 1:5-13.)

313. Rovaart provides that, because “it is desired to impart” “the taste of meat” to its food products, the Rovaart products “are subsequently given a flavouring treatment.” (EX1125, 1:24-26.) Specifically, Rovaart teaches that its “invention is concerned with a process for preparing an expanded porous food product having a meat-like flavour,” comprising a series of steps:

The present invention is concerned with a process for preparing an expanded porous food product having a meat-like flavour that is particularly simple and in which the desired texture and taste are obtained in a single operation. ***This process comprises forming a mixture comprising (a) a finely divided food material (b) at least one pentose or hexose, (c) at least one sulphur-containing amino-acid or an amino-acid and a substance containing sulphur, and (d) water***, the mixture containing from 18 to 45% by weight of water, ***heating the mixture to a temperature of at least 150°C*** under a pressure which is at least equal to the saturated vapour pressure of water at the temperature to, which the mixture is heated, and thereafter rapidly reducing the pressure to which the mixture is subjected to vaporise the major proportion of the water contained in the mixture thereby forming an expanded porous structure in its interior.

EX1125, 1:38-48. As I discuss further below, the terms “pentoses” and “hexoses” listed in step (b) of Rovaart’s method refer to sugars. A POSITA would recognize that the sugars and the “substance containing sulphur” listed in steps (b) and (c) of Rovaart’s method serve as Maillard reaction precursors which, when heated as

recited in Rovaart's method, produce volatile compounds associated with the flavor and aroma of meat.

314. Thus, Rovaart discloses methods of preparing plant-based meat-like food products that simulate sensory experiences associated with eating real meat, but—because these products are created using plant-derived materials—they avoid the disadvantages associated with real, conventionally-sourced meat (discussed above in Section VIII.A.1. Rovaart is therefore from the same field of endeavor as the '306 patent and is reasonably pertinent to the problem facing the named inventors of the '306 patent. For example, a POSITA would have consulted Rovaart (for example, for its teachings of methods of creating meaty aromas) in order to develop foodstuffs that simulate the flavors and aromas of real meat and thereby appeal to a broad consumer base, including consumers who would ordinarily eat real meat.

315. A POSITA would recognize other advantages associated with Rovaart's food products. For example, Rovaart teaches that the methods of manufacturing its products are “particularly simple” and efficient:

The present invention is concerned with a process for preparing an expanded porous food product having a meat-like flavour that is ***particularly simple and in which the desired texture and taste are obtained in a single operation.***

EX1125, 1:39-42.

B. Rovaart, Conrad, and Crane Render Obvious Claims 1, 3–6, 13–14, 16–18, 24, 26–27, and 29–33 of the '306 Patent

316. As explained below, in my opinion, claims 1, 14, and 27 of the '306 patent are obvious.

1. Claims 1[pre], 14[pre], 27[pre]

317. The preamble to these claims is not limiting for reasons I explain above (Section XI.A). To the extent the preamble is limiting, Rovaart teaches these limitations. For example, limitation 1[d] recites “[a] **method for imparting a beef-like aroma to a meat replica matrix.**”

318. As explained further below with respect to limitation [a], **Rovaart** discloses a meat replica matrix prepared from (for example) plant-derived materials, and methods of imparting beef-like aromas and flavors thereto. These products replicate other aspects of real meat; for example, its texture. Rovaart provides:

Starting from *a substance rich in protein*, or a powdered product containing animal or microbial proteins, *the final product has a fibrous structure analogous to the texture of meat and a meat-flavour.*

EX1125, 3:13-16.

319. Rovaart further discloses that “[t]he products..., to the extent that *it is desired to impart to them the taste of meat, are subsequently given a flavouring treatment.*” EX1125, 1:24-26. This approach includes using “suitable flavoring agents,” which can be “natural.” EX1125, 1:26-29. In particular, as explained below for limitation [b], Rovaart teaches incorporating the claimed sugars and sulfur-

containing compounds into its products, which a POSITA would understand would impart a beef-like aroma to Rovaart's meat replicas upon cooking.

320. Additionally, as I explain for limitation [c], a POSITA would be motivated to further enhance the meaty flavors and other meat-like properties of Rovaart's product using between 0.01%-5% leghemoglobin as taught in Conrad and Crane. For example, Conrad discloses that incorporating hemoglobin in a grain (plant)-based meat replica improves its meat-like flavor as well as meat-like color, another generally-desirable attribute in a meat replica such as Rovaart's food products.

321. As explained below for limitation [d], a POSITA would recognize that the sugar and sulfur compounds incorporated in Rovaart's food products generate at least two volatile compounds associated with beef-like aroma when heated. The products described in multiple Rovaart Examples have meaty, beef-like aromas.

2. Claims 1[a], 14[a], 27[a]

322. **Rovaart** teaches these limitations. For example, limitation 1[a] recites: **“wherein the meat replica matrix comprises one or more plant proteins.”**

323. Rovaart teaches that its “meat-like” food products comprise one or more plant proteins. For example, its products can be prepared from ***“flour or meal of vegetable origin ... or from substances rich in protein of plant ... origin.”*** EX1125, 1:5-13.

324. In particular, Rovaart teaches that the “soya bean” flour (which a POSITA would understand to mean “soybean”) used in Rovaart’s methods contains protein. For example, Rovaart’s “process comprises forming a mixture comprising (a) a finely divided food material,” which refers to “material in the form of particles...such as...a material **rich in protein**, for example **soya bean flour**...” (EX1125, 1:42-44, 56-62.) As a POSITA would recognize, soybeans (and flour made from soybeans) are obtained from soybean **plants**. The ’306 patent confirms this conventional understanding. For example, it provides that “[n]on-limiting examples of **plant sources** include ... plants from the legume family ... e.g., ... soybeans...” (EX1001, 18:34-58.) Thus, Rovaart teaches meat replica products that comprise one or more plant proteins.

325. Additionally, multiple Examples in the Rovaart reference utilize soybean flour in order to achieve food products that have meaty aromas. For example, the Example 1 product comprises “10 kg of defatted soya bean flour” and the Example 2 and 4 products comprise “1000 g of a defatted soya bean flour...” EX1125, 3:33-35, 5:23-24, 6:21-23.

3. Claims 1[b], 14[b], 27[b]

326. **Rovaart** teaches these limitations. For example, limitation 1[b] recites “a sugar selected from glucose, ribose, sucrose, fructose, xylose, maltodextrin,

and combinations thereof, and at least one sulfur compound selected from methionine, cysteine and thiamine.”

327. Rovaart teaches including the claimed sugars and sulfur compounds in its products in order to achieve meat-like aromas. As a POSITA would recognize, these sugars and sulfur compounds are Maillard reaction precursors long known to produce volatile compounds associated with meaty aromas when heated. I discuss this reaction further below (limitation [d]). I also rely on and adopt Dr. McGorin’s discussion of Maillard reaction chemistry, which is consistent with my experience. EX1005 Section V.B.

328. Rovaart discloses that its “process for preparing an expanded porous food product having a meat-like flavour...comprises forming a mixture comprising...(b) at least one pentose or hexose, (c) at least one sulphur-containing amino-acid or an amino-acid and a substance containing sulphur...” EX1125, 1:38-46.

329. Rovaart further discloses specific examples of these sugars (pentoses and hexoses) and “sulphur compounds,” the latter of which may be provided by “a hydrolysed plant protein,” and provides general guidance as to the amounts to use in preparing Rovaart’s food products:

The pentose or hexose, for convenience referred [sic] to as glucose, may be *D-ribose*, *D-xylose*, *L-arabinose* or *glucose*. *Cysteine is the preferred sulphur-containing amino-acid*, but as an alternative an

amino-acid not containing sulphur, such as alanine, may be used together with a substance containing sulphur, for example hydrogen sulphide or sodium sulphide. ***A hydrolysed plant protein may advantageously be used as the source of the amino-acids.*** The respective quantities of these substances may be selected over a very wide range according to the nature of the food product starting material and the characteristics of structure and taste which it is desired to impart to the final product. In general, it is preferable to use a total quantity of glycoses (s) and of amino-acid or acids equal to 0.5 to 3% by weight of the dry-matter in the food material, the molar ratio of glycoses to amino-acid (glycoses/amino acid) being preferably between 0.5 and 2 to 1, and advantageously at least 1:1. Mixtures of two or more glycoses, and/or amino acids, may also be used.

EX1125, 1:66-2:18. Rovaart also teaches that additional flavoring agents can be used in its products (2:18-22):

Moreover, ***flavouring*** and/or texturing ***agents*** such as sodium glutamate, inosine or guanosine monophosphate, lactic acid, calcium chloride or sodium chloride ***may also be added to the mixture.***

330. Rovaart's Examples disclose specific combinations of the claimed sugars and sulfur compounds that serve as Maillard reaction precursors in Rovaart's products. For example, the Example 1 methods comprises "83.3 g D-***ribose***, 66.7 g L-***cysteine***," Example 2 comprises "D-***Xylose***" and "L-***Cysteine***," Example 3 comprises "7.5 g ***ribose*** and 7.5 g ***cysteine***," and Example 4 comprises ***glucose*** and ***cysteine***. EX1125, 3:32-37, 5:10-16, 5:38-40, 6:17-20.

331. As a POSITA would understand, these precursors will react upon heating of the exemplary products (as taught in the Examples) in order to produce meaty aromas. As discussed below (limitation [d]), Rovaart teaches that heating the products described in its Examples produce such aromas.

4. Claims 1[c], 14[c], 27[c]

332. These limitations are obvious in light of the teachings of Rovaart, Conrad, and Crane. For example, limitation 1[c] recites “**adding 0.01%-5% (by weight of the meat replica matrix) of a non-animal heme-containing protein to the meat replica matrix.**”

333. As discussed further below, **Conrad** teaches a motivation to add between 0.01% and 5.0% of heme-containing protein (by weight) to a meat replica, and a POSITA would be motivated to substitute Conrad’s blood-sourced hemoglobin protein in **Rovaart**’s products with **Crane**’s purified leghemoglobin, which contributes the same desirable coloration, flavor, and nutritive benefits as hemoglobin, with a reasonable expectation of success.

334. **Rovaart** generally motivates a POSITA to provide meaty flavor in its products and teaches methods for doing so (see limitation [b] above). For example, Rovaart states that “[t]he present invention is concerned with *the preparation of porous expanded food products having a meat-like taste.*” (EX1125, 1:5-7.) To this end, Rovaart teaches including “*suitable flavouring agents*” in its products,

“which may be natural.” EX1125, 1:24-29. Rovaart teaches adding sugars/sulfur-compounds for this purpose (see limitations [b], [d]).

335. In addition, Rovaart teaches methods of **enhancing**—and not merely producing—meaty flavor, which a POSITA would recognize as advantageous for preparing a meat-like foodstuff. These methods include increasing the products’ cooking temperature. For example, Rovaart teaches that “**heating** [Rovaart’s composition] **at a temperature below 150°C does not produce the desired flavour**” of its products. (EX1125, 2:46-51.) Accordingly, Rovaart teaches advantages of cooking its products at a higher temperature (150°C or higher, as reflected in its Examples) in order to improve the desirability of the food products by achieving an improved meat-like flavor.

336. Rovaart also teaches that changing its manufacturing processes can affect the desirability of its food products. For example, Rovaart teaches that substituting sugars in the Examples’ recipes can produce “**less pronounced**” meaty flavors in certain embodiments. (EX1125, 6:16-28, 6:48-52.) For example, Rovaart’s Example 4 “product [has] a meat-like texture and the flavour of boiled beef, although slightly less pronounced than that of the product obtained in Example 2.” (EX1125, 6:16-28.) A “less pronounced” meaty flavor—although still meat-like—would be undesirable to a POSITA seeking to achieve meat-like flavors in meat replica foodstuffs.

337. Thus, a POSITA would be generally motivated by Rovaart itself to use techniques and ingredients that **enhance** the meaty flavor of Rovaart’s food products. As taught in Rovaart, a POSITA would recognize that one way to do so would be to include other “suitable flavouring agents” in the products, including “natural” flavoring agents. EX1125, 1:24-29.

(a) Motivation to Combine with Conrad

338. To further enhance Rovaart’s products’ meaty flavor, **Conrad** teaches a POSITA that adding “up to” 5% heme-protein (by weight) would contribute meaty flavor in addition to other benefits. As discussed below, a POSITA would be motivated to combine Rovaart with Conrad, with a reasonable expectation of success.

339. As discussed further above (Section XII), Conrad discloses “grain meat”/“wheat meat” meat replica matrices that advantageously contain the heme-protein hemoglobin. In particular, Conrad teaches adding the “hemoglobin part” of slaughtered-animal blood to the grain-based “meat” confers multiple properties characteristic of meat: *first*, the color of the grain-based replica “**can advantageously be transferred into meat colour** by adding thereto ... blood,” and *second*, the “**addition of blood/hemoglobin further gives a desired taste improvement as it improves the meat flavour of the final product.**” (EX1013(Conrad), 4:3-17.)

340. Conrad also teaches levels of heme-protein in foodstuff products that achieve these desirable meat-like properties of color and flavor. I reproduce below Conrad's disclosure on this point, as well as my analysis with respect to the Conrad ground (Section XII).

The wheat meat described has a brown-yellow colour deriving partly from the brown bran and partly from the yellow gluten. The colour can advantageously be transferred into meat colour by adding thereto up to 15% by weight of blood, preferably ***the hemoglobin part separated off from blood, the protein content of which is about 90% by weight and the dry substance contents are 33% by weight.***

It is to be noted that the dry substance contents of wheat meat are about 33 to 35% by weight and the addition of blood thus not changes the dry substance. The addition of blood/hemoglobin further gives a desired taste improvement as it improves the meat flavour of the final product.
(EX1013(Conrad), 4:3-17.)

341. Specifically, to achieve these goals, Conrad discloses utilizing the ***“hemoglobin part*** of whole blood” in its grain-based “meat.” (EX1013(Conrad), 1:56-61, 4:5-10). Red blood cells are well-known to contain hemoglobin protein. (E.g., Weed (1963) (EX1139).) The levels of hemoglobin in red blood cells are also long known in the art. As reproduced below, Tables 1 and 2 of Weed (1963) disclose proportions of hemoglobin and other components in the “dry weight” (non-water portion) of red blood cells (versus hemoglobin-depleted “ghost” cells).

TABLE I
Hemoglobin content per cell of red blood cells and ghosts

	Red blood cells (n = 14)	Ghosts (n = 24)
Hemoglobin, g $\times 10^{-12}$	30.99 $\pm$ 0.12 (SD)	0.015 $\pm$ 0.009 (SD)
Hemoglobin, % dry weight	97	1.4

TABLE II
*Lipid content per cell of intact red blood cells and ghosts**

Lipids	Red blood cells	Ghosts	p
Total lipid, g $\times 10^{-12}$	4.91 $\pm$ 0.33	4.95 $\pm$ 0.33	> 0.60
Total cholesterol, g $\times 10^{-12}$	1.13 $\pm$ 0.08	1.08 $\pm$ 0.06	> 0.05
Total lipid phosphorus, μ g $\times 10^{-9}$	11.89 $\pm$ 0.68	11.47 $\pm$ 0.85	> 0.40
Individual phospholipids,† μ g P $\times 10^{-9}$			
Sphingomyelin	3.12 $\pm$ 0.14	2.91 $\pm$ 0.26	> 0.05
Lecithin	3.37 $\pm$ 0.19	3.28 $\pm$ 0.22	> 0.40
Phosphatidyl serine	1.79 $\pm$ 0.22	1.84 $\pm$ 0.09	> 0.40
Phosphatidyl ethanolamine	2.39 $\pm$ 0.26	2.31 $\pm$ 0.23	> .040
Other‡	1.22 $\pm$ 0.07	1.13 $\pm$ 0.07	> 0.40

* Mean values $\pm$ SD are given for preparations from nine hematologically normal subjects. p was determined by *t* test (20).

† Plasmalogens, where present, were analyzed with the parent compounds.

‡ This includes lysolecithin, inositol phosphatide, and polyglycerol phosphatide, which together constitute about 10% of the total lipid phosphorus of the red blood cell (11).

342. A POSITA would therefore understand Conrad's reference to the "hemoglobin part" of blood to mean **red blood cells**.

343. Consistent with this understanding, Conrad teaches that "the **dry substance contents** [of the "hemoglobin part"] are 33% **by weight**." (EX1013(Conrad), 4:5-10.) I note that Conrad refers to "protein content" values before it refers to "dry substance" values, but a POSITA would understand that the

90% “protein content” value necessarily refers to the “dry substance” because the 66% (non-dry) remainder is water, which is not protein. In particular, a POSITA would understand that this “dry weight” portion of the “hemoglobin part” refers to the components of the **red blood cells** that are **not water**—for example, proteins or lipids that may also be present in the cells.

344. Within this “dry weight” portion of Conrad’s “hemoglobin part,” Conrad teaches that its “the **protein content**” “is **about 90% by weight**.” EX1013(Conrad), 4:5-10. Although Conrad’s disclosure regarding the components of the “protein content” is not precise—for example, because Conrad does not teach particular methods for obtaining or purifying the “hemoglobin part” for use in its products—a POSITA would understand from the context of Conrad that Conrad teaches that the “**protein content**” of the “hemoglobin part” relates to **hemoglobin** itself—the protein known in the art to contribute to the desired meat-like flavor and color of Conrad’s products.

345. My interpretation of the “**protein content**” is reflected in Conrad’s choice of the term “**hemoglobin** part” to describe this fraction. My interpretation is also consistent with Conrad’s description of the components of this fraction in light of the art’s teaching of hemoglobin levels in red blood cells. Specifically, by using the term “**about**” to modify “90%,” for example, Conrad is identifying an **estimate of the levels of hemoglobin protein in the “dry weight” fraction of the “hemoglobin**

part.” (Conrad does not define the scope of “about.”) In fact, the amount of hemoglobin could be different (and could potentially be higher than 90%, as taught in the art). EX1139 (Weed (1963)), 584 (“**[H]emoglobin ... accounts for 97% of [a red blood] cell’s dry weight**”). A POSITA would understand that Conrad is merely providing an approximation of the amount of hemoglobin in the “dry” fraction of the “hemoglobin part.” Thus, when Conrad’s teachings are read together, a POSITA would understand that the “**about 90%**” *term refers to the proportion of hemoglobin protein in the “dry weight” fraction.*

346. My interpretation of Conrad is consistent with its description of its Table 2 meat replica embodiment—“Wheat Meat CH” (containing “Cheese fines” and “Hemoglobin” in addition to “Wheat Meat”), reproduced below:

TABLE 2				
Product	Amount in g	DS in %	Protein in DS %	Protein in g
Wheat meat	1,500	33	46	230
Cheese fines	500	33	85	140
Hemoglobin	100	33	90	30
Wheat meat <u>CH</u>	2,100	33	57	400

347. As shown in Table 2, Conrad teaches that only **30 grams** of the **100-gram** “Hemoglobin” component of the “Wheat Meat CH” embodiment are “protein.” In other words, the “Hemoglobin” in “Wheat Meat CH” is only comprised of 30% protein.

348. This proportion is consistent with the teachings of Conrad explained above. If “Hemoglobin” meant only hemoglobin *protein*, for example, the “protein” value would be 100 grams (100% of the total) rather than only 30 grams. Specifically, assuming that the 100-gram “Hemoglobin” in Table 2 refers to the “hemoglobin part” added to the “wheat meat,” 33% of that “Hemoglobin” (“hemoglobin part”) is “dry weight.” Within that “dry weight” portion of “Hemoglobin,” about 90% of the “dry weight” is hemoglobin. This translates to approximately 30% grams of hemoglobin as shown below:

“Hemoglobin” (hemoglobin part)	“Dry Weight” portion of “Hemoglobin”	Heme-Protein (hemoglobin) portion of “Hemoglobin”
100 grams	(0.33 x 100 grams) = 33 grams	(0.9 x 33 grams) = 29.7 grams (about 30 grams)

349. The entire Table 2 “Wheat Meat CH” embodiment is 2100 grams. The percentage of hemoglobin in this whole product is therefore 29.7 grams (hemoglobin) divided by 2100 grams (product) (which equates to 0.01415 grams), multiplied by 100. Thus, the Table 2 embodiment comprises approximately **1.4%** of the heme-protein hemoglobin. This value is within the claimed 0.01%-5.0% range of (“non-animal”) heme-containing protein.

350. Conrad teaches other embodiments with higher heme-protein concentrations. For example, Conrad teaches adding the “hemoglobin part” “up to

10% by weight *dry weight* of the gluten-bran product *dry weight*.” EX1013(Conrad), 1:56-61. This teaching calculates the “dry weight” of the “hemoglobin part” in the meat replica based on the “dry weight” of the gluten/bran components in the replica. This teaching can be applied to Conrad’s Table 1 “wheat meat” embodiment. I reproduce Table 1 below.

TABLE 1			
Compound	Meat		
	Beef	Swine	Wheat meat
Water	73%	65%	65%
Starch	0%	0%	3%
Bran-fiber	0%	0%	14%
Proteins	22	19%	15%
Fat	3%	12%	0%
Wheat germ incl. wheat germ oil	0%	0%	2.5%
Salts	2%	4%	0.5%
	100%	100%	100%

351. Table 1’s “wheat meat” contains 65% water and 35% non-water (dry weight or “DW”) components, respectively. I arrive at the 35% value of “dry” components by subtracting “65%” water (set forth in Table 1) from the total (100%).

352. Applying Conrad’s teachings to Table 1’s “wheat meat,” adding the “hemoglobin part” contribute “up to 10%” of the “wheat meat” embodiment’s dry components. EX1013(Conrad), 1:56-61. Because the embodiment is itself comprised of 35% dry components, multiplying the dry components (35%) by 10%

(or 0.10) equates to 3.5% of the dry components contributed to the “wheat meat” from the “hemoglobin part.”

353. Within the 3.5% of dry components contributed by the “hemoglobin part,” “about 90%” is hemoglobin for reasons I explain above. Using the 90% value, the amount of hemoglobin in the whole “wheat meat” embodiment of Table 1 represents **3.15%** of the total embodiment (3.5% x 0.9). I summarize this calculation below.

“Hemoglobin Part”’s DW Percentage of Wheat Meat DW	Bran/Gluten DW	DW contributed to Total “Wheat Meat” by “Hemoglobin Part”	Heme-Protein (hemoglobin) portion of “Hemoglobin Part” DW
10%	35% of total (65% is water)	(0.10 x 35%) = 3.5%	(0.9 x 3.5%) = 3.15%

354. Conrad also teaches that adding “**up to 15%** by weight of” the “wheat meat” using “preferably the hemoglobin part” of blood provides desirable meaty color. (EX1013(Conrad), 4:5-10.) Following the same principles, as summarized below, the “up to 15%” limitation represents about **4.5%** (by weight) heme-protein in Conrad’s “wheat meat.”

“Hemoglobin” (hemoglobin part) in Wheat Meat	“Dry Weight” portion of “Hemoglobin”	Heme-Protein (hemoglobin) portion of “Hemoglobin”
15%	(0.33 x 15%) =	(0.9 x 4.95%) =

“Hemoglobin” (hemoglobin part) in Wheat Meat	“Dry Weight” portion of “Hemoglobin”	Heme-Protein (hemoglobin) portion of “Hemoglobin”
	4.95%	4.455% (about 4.5%)

355. As shown above, Conrad teaches “up to 15%” “hemoglobin part” (4.5% of the total product). Conrad does not teach a lower limit of this range and in fact teaches that heme-protein is an optional component (i.e., a value of “0” on the range). EX1013(Conrad), 1:56-61 (describing adding the “hemoglobin part” as a “*preferred* embodiment”). Similarly, Conrad’s Abstract provides that “a blood hemoglobin fraction” “*can* be added” to Conrad’s meat replacements.

356. Thus, Conrad motivates a POSITA to add between 0.01%-5% heme-protein to replicas (e.g., Rovaart’s “meat-like” food products) in order to achieve desirable meat-like properties, with a reasonable expectation of success. The range of heme-protein taught as advantageous in Conrad almost completely overlaps with the claimed range.

357. Additionally, a POSITA would understand that incorporating levels of heme-protein within the lower boundary of the claimed range could replicate proportions of heme-protein naturally present in various kinds of meat (see Section XII (Ground 1)). Different kinds of meat have different compositions. For example, as taught in the Pearson treatise, percentages of myoglobin differ across meats. EX1027, 65 (teaching, e.g., “veal, 1 to 3 mg/g [0.1-0.3%]; beef, 4 to 10 mg/g [0.4-

1.0%]; and old beef animals, 16 to 20 mg/g [1.6-2.0%]. Pork contains 1 to 3 mg/g for young animals...[0.1-0.3%]”). A POSITA would understand that it could be desirable to enhance the “meat-like” characteristics of Conrad’s meat replacements depending on the individual type of meat being replicated and the levels of heme-protein that naturally occur in that type of meat. Thus, in order to create replacements for meats that naturally contain lower levels of myoglobin (e.g., veal or young pork), a POSITA would be motivated to incorporate heme-protein in Conrad’s meat replacements at levels approaching the lower bound of the claimed heme-protein range (**0.01%**-5%).

(b) Motivation to Combine with Crane

358. As explained further above for Ground 1 (Section XII), a POSITA would be motivated to substitute Conrad’s blood-sourced hemoglobin with Crane’s recombinantly-produced heme-proteins, with a reasonable expectation of success.

359. *First*, because a POSITA would be aware of general motivations in the art to reduce consumption of conventionally-sourced meat and animal products, a POSITA would be motivated to substitute Conrad’s conventionally-obtained hemoglobin (as used in **Rovaart**’s food products) with heme-proteins from alternative sources. E.g., obtaining blood from slaughtered animals incurs the same environmental consequences, expenses, and other ramifications as cultivating animals for meat. See Section VIII.A.2-4.

360. **Conrad** teaches or suggests this motivation, as Conrad teaches utilizing meat replicas in place of “animal meat.” EX1013(Conrad), 1:25-40 (“It is also known to replace some of the animal meat...”).

361. **Crane** also teaches or suggests this motivation, as Crane teaches using its recombinant heme-proteins in place of conventionally-sourced proteins. EX1014, [0062] (“Recombinant hemoglobin preparations are used as effective and safe oxygen carriers as an alternative to blood transfusion.”).

362. Second, **Conrad** teaches avoiding conventionally-sourced meat due to its relative expense, and it teaches preparing its products with the aim of lowering costs of manufacture. EX1013(Conrad), 1:25-40 (teaching that “**replac[ing]** some of the **animal meat tending to be somewhat expensive** with...protein rich vegetable product,” “would be **desirable...from a cost benefit point of view...**”).

363. **Crane** also provides a motivation to address financial considerations associated with conventionally-sourced animal products. Crane teaches that heme-proteins can be produced via a “**simple and inexpensive method**” which “is effective at producing fully incorporated heme proteins.” EX1014, [0085]; [0014] (“The present invention is a straightforward and **inexpensive method** for high fidelity incorporation of heme into recombinantly overexpressed heme proteins.”); [0043] (“**fungal** [expression] **systems are more efficient and economical...**”).

364. *Third*, Crane’s heme-proteins can be purified (EX1014, [0024], [0060]-[0062]), which a POSITA would understand is generally desirable for a commercial application such as **Rovaart’s** “meat like” food products. In my experience, it is easier to prepare foodstuffs such as Rovaart’s products using purified ingredients that are standardized. For example, Crane’s purification methods prevent the introduction of *undesired* components into the food products, such as cellular debris and materials from Crane’s expression system. Additionally, cellular materials from Crane’s expression system might affect stability—if they contain lipid or enzymes, for example, that could affect the food product or potentially the leghemoglobin itself. Thus, a POSITA would be motivated to utilize Crane’s purified heme-proteins instead of slaughtered-animal blood.

365. As discussed further above (Ground 1, Section XII), Crane teaches producing various heme-proteins, which include leghemoglobin. EX1014, [0021] (“The ... heme-binding proteins ... encompassed by the methods ... include ... e.g., hemoglobin, myoglobin...leghemoglobin ...”). A POSITA could thus obtain recombinant leghemoglobin using the methods of Crane.

366. A POSITA would be motivated to utilize hemoglobin, myoglobin or leghemoglobin in Rovaart’s products because, as explained further below, a POSITA would expect doing so to contribute (1) **desirable meat-like coloration**, (2) **desirable aroma/flavor**, and (3) **desirable meat-like nutrition**.

367. Color: A POSITA would understand that heme-proteins (e.g., myoglobin and hemoglobin) are “predominant” red pigments in animal muscle and denature when heated, causing meat’s browning. EX1027, 64; EX1094, 82 (denaturation leads to “dull-brown” meat color).) As Crane’s recombinant hemoglobin and myoglobin are the same as those heme-proteins found in animal muscle, a POSITA would expect them to contribute to color in the same manner.

368. Likewise, leghemoglobin is structurally similar to myoglobin and provides meat-like color to plants. EX1030, 79 (leghemoglobin is “red pigment isolated from soybean root nodules”), EX1135 (Nicola); EX1133 (Hargrove). A POSITA would therefore expect **Crane**’s recombinant leghemoglobin to achieve similar meat-like coloration in **Rovaart**’s food products as myoglobin and hemoglobin achieve due to their presence in real meat.

369. Aroma: As Crane’s recombinant hemoglobin is the same as Conrad’s hemoglobin, a POSITA would expect it to contribute to flavor in the same manner.

370. Leghemoglobin is structurally similar to hemoglobin and myoglobin—particularly myoglobin. EX1135, 133 (Nicola) (“Leghaemoglobins are plant haemoproteins which resemble animal myoglobins...”); EX1133, 1032 (Hargrove) (“[T]ertiary folding patterns of...soybean Lb are very similar to those of mammalian myoglobins, and the α and β subunits of human hemoglobin...”). A POSITA would

therefore expect leghemoglobin to contribute to flavor in the same manner as hemoglobin and myoglobin.

371. Nutrition: As I discuss further above (Background Section VIII), meat is an important dietary source of iron for many, and “haem [sp: heme] iron [is] more readily absorbed and utilised by the body” than other forms of iron. EX1029, 329. For example, the heme-protein myoglobin provides 95% of the iron in beef muscle. EX1027, 64-65. Crane’s recombinant myoglobin, hemoglobin, and leghemoglobin are “fully incorporated” with heme iron and would therefore be desirable to enhance the nutrition profile of Rovaart’s products. EX1014, [0080], [0084]-[0085].

5. Claims 1[d], 14[d], 27[d]

372. Rovaart discloses these limitations. For example, limitation 1[d] recites **“wherein, upon cooking of the meat replica matrix, at least two volatile compounds are generated that are associated with a beef-like aroma, thereby imparting a beef-like aroma to the meat replica matrix.”**

373. Rovaart teaches cooking its meat replica products. Rovaart’s process comprises “heating the mixture to a temperature of at least 150°C,” “preferably ... at a temperature of between 160° and 180°C,” under pressures “sufficient to produce a meat flavour in the interior of the final product.” EX1125, 1:38-48, 2:63-68.

374. As a POSITA would recognize, heating the Rovaart products will naturally generate at least two compounds associated with beef-like aroma. As

explained above for Ground 1, the art long taught that when sugars and sulfur compounds (e.g., as used in Rovaart's products, as discussed with respect to limitation [b] above) are heated together, they will undergo the Maillard reaction to produce many (hundreds) volatiles associated with meaty aromas, including meat's character-impact compounds. EX1005 Sections V.A-B (reviewing EX1017, EX1032–1034, EX1038, EX1041, EX1045, EX1099, EX1129).

375. A POSITA would reasonably expect success in achieving the claims at least because this result is taught or suggested in Rovaart itself. For example, heating Example 2's product (containing xylose/cysteine) "at 158°C" "provides **a product having the flavour of boiled beef** and a meat-like texture." EX1125, 5:10-36. A similar "boiled beef" flavor is produced when the same process is performed, substituting glucose for xylose. EX1125, 6:16-28 (Example 4). Heating Example 3's product (containing ribose/cysteine) "at 180°C" also produces a "**flavour ... similar to that of roast beef.**" EX1125, 5:38-49.

376. Although Rovaart does not explicitly disclose specific volatile compounds produced as a result of Rovaart's methods, a POSITA would understand Rovaart to teach that, upon cooking of its food products containing the claimed sugars and sulfur compounds, volatile compounds are generated that are associated with a beef-like aroma, thereby **imparting a beef-like aroma to Rovaart's meat replica products.**

377. Moreover, only ordinary skill would be required to prepare and assemble the individual components—for example, **Crane**’s purified recombinant leghemoglobin—into **Rovaart**’s meat replica matrix and heat to generate at least two volatile compounds associated with beef-like aroma. Rovaart teaches conventional methods of mixing, heating, and extruding ingredients. For example, Example 1 discloses methods of mixing “soya bean flour” containing 53.5% protein “with 3250 g of an aqueous solution” containing ribose and cysteine. (EX1125, 3:32-62 (“The resulting dough ... is introduced into the feed hopper of an extruder ... The dough is ... advanced ... at a temperature of 160°C...”).) Example 2 provides a similar teaching to achieve a meat replica food product (EX1125, 5:25-34):

The dough is then fed into the extruder described in Example 1, worked mechanically at 158°C for 25 seconds and extruded into atmospheric pressure. An expanded, fibrous material is obtained, containing 6.3% moisture and which, after rehydration by immersion in water at 100°C for 20 minutes provides ***a product having the flavour of boiled beef and a meat like texture.***

6. Claims 3, 16, 29

378. In my opinion, claims 3, 16, and 29 are also obvious. E.g., claim 3 recites that “**the non-animal heme-containing protein has a UV-VIS spectrum that is substantially similar to that of myoglobin from an animal.**”

379. As I explain in greater detail above (claims 1, 14, 27), a POSITA would be motivated to utilize **Crane**'s recombinant leghemoglobin or myoglobin in Rovaart's meat-like food products, with a reasonable expectation of success.

380. Both **Crane**'s leghemoglobin and myoglobin have a UV-VIS spectrum that is substantially similar to that of myoglobin from an animal. As a POSITA would recognize, Crane's recombinant myoglobin is the *same* protein as myoglobin "from an animal," but differently sourced.

381. As discussed in greater detail with respect to claims 3, 16, and 29 in Ground 1 of this Declaration, the art taught a high degree of structural homology between heme-proteins such as myoglobin and hemoglobin (e.g., the blood-sourced hemoglobin disclosed in Conrad) with leghemoglobin, a "non-animal" (plant) protein. EX1135 (Nicola), 133, 139; EX1133, Hargrove, 1032.

382. Additionally, as disclosed in the Brown reference, the Patent Owner has acknowledged that leghemoglobin naturally "has a virtually identical absorbance spectrum and visual appearance to myoglobin from animal muscle." EX1012, [00377] & Figure 5.

7. Claims 4, 17, 30

383. In my opinion, claims 4, 17, and 30 are also obvious. For example, claim 4 recites that "**heme-containing protein is selected from the group consisting of a leghemoglobin, a flavohemoglobin, Hell's gate globin I, an**

erythrocruorin, a protoglobin, a cyanoglobin, a chlorocruorin, a truncated hemoglobin, a truncated 2/2 globin, and a hemoglobin.”

384. As explained more fully above (claims 1, 14, 27), a POSITA would be motivated to replace Conrad’s conventionally-sourced hemoglobin with **Crane’s** leghemoglobin for use in Rovaart’s products, with a reasonable expectation of success (for example, because Crane teaches methods of making and purifying heme-proteins, including leghemoglobin). Additionally, for example, like that hemoglobin from slaughtered-animal blood that is used in Conrad’s products, leghemoglobin has a red, meat-like pigment that would be desirable for coloring meat replica foodstuffs. EX1013(Conrad), 1:56-61

385. Moreover, and as discussed in greater detail with respect to claims 4, 17, and 30 in Ground 1, a POSITA would also recognize that a variety of “non-animal” heme-proteins, such as plant hemoglobins, could be manufactured and obtained using **Crane’s** techniques and could also be used for the desired purposes. EX1030 (reviewing “six decades” of research on plant hemoglobins); EX1014, [0021] (“[C]lasses of heme-binding proteins that are encompassed by the methods of the present invention include ... hemoglobin, ... The recombinant heme-binding protein produced using the methods of the present invention can be prokaryotic or eukaryotic.”). The genetic sequences of plant hemoglobins were also available to a POSITA. For example, Garrocho-Villegas discloses that “Hbs [hemoglobins] are

widespread in organisms, as *they have been identified in genomes of* archaeobacteria, eubacteria and eukaryotes, including *plants...*” (EX1030, 78; also page 80 (“In addition to Lbs [leghemoglobins] and nsHbs [non-symbiotic hemoglobins], Hb [hemoglobin] *sequences* that are similar to those of microbial truncated (2/2) Hbs ... *were detected in primitive and evolved plants (Table 1)*”); page 81 (Table 1) (listing sequences).)

8. Claims 5, 18, 31

386. In my opinion, claims 5, 18, and 31 are also obvious. For example, claim 5 recites “**incorporating into the meat replica matrix 0.4%-1% (by weight of the meat replica matrix) of the non-animal heme-containing protein.**”

387. As explained more fully above (claims 1, 14, 27), **Conrad** teaches advantages of incorporating between 0.01 and 5.0% of blood-sourced heme-protein in Rovaart’s meat-like food products, which a POSITA would be motivated to replace with **Crane**’s leghemoglobin with a reasonable expectation of success (for example, because Crane teaches methods of making and purifying leghemoglobin). This heme-protein range encompasses, and thus renders obvious, the claimed 0.4%-1% range of non-animal heme-containing protein.

388. Additionally, a POSITA would be motivated to incorporate a “non-animal” heme-protein such as leghemoglobin in meat replica products at levels that approximate the levels of heme-protein naturally present in the type of meat being

replicated. As certain kinds of beef muscle naturally contain myoglobin in ranges that span between approximately 0.4% and 1.0% (EX1027, 65), for example, a POSITA seeking to replicate real beef using a “meat-like” Rovaart product would be motivated to incorporate between approximately 0.4 and 1.0% by weight of “non-animal” heme-protein (e.g., leghemoglobin) in the Rovaart product. I also incorporate here my analysis regarding claims 5, 18, and 31 in Ground 1.

9. Claims 6, 24

389. In my opinion, claims 6 and 24 are also obvious. For example, claim 6 recites that “**the non-animal heme-containing protein is purified.**”

390. As explained above (claims 1, 14), a POSITA would be generally motivated to purify heme-proteins for use in a foodstuff such as **Rovaart**’s meat-like food products because doing so would be expected to reduce or eliminate components of the production process that contribute objectionable flavors.

391. A POSITA would reasonably expect success in doing so, for example, because **Crane** teaches methods of producing purified heme-protein preparations by separating heme-proteins from other components of Crane’s expression systems, e.g., via cleavable “tags” attached to the protein when it is initially expressed. EX1014, [0060]-[0062]; *see also id.* [0074]. Crane teaches that, for example, “[i]n a preferred embodiment of the present invention, the purified preparation of functional recombinant heme binding protein is prepared in accordance with the

methods described supra.” EX1014, [0061]. In one specific example of Crane’s method, Crane discloses that its heme-proteins “were ***purified to >95% purity*** using size exclusion chromatography after the removal of” a His-tag (“6xHis”). EX1014, [0075].

392. The proteins that can be purified by Crane’s purification methods include “non-animal” heme-proteins such as leghemoglobin. EX1014, [0021] (also discussing other kinds of non-animal heme-proteins, such as “prokaryotic” heme-proteins).

10. Claims 7, 19

393. In my opinion, claims 7 and 19 are also obvious. For example, claim 7 recites that “**at least one of the one or more plant proteins is isolated.**”

394. As explained further above regarding Ground 1, the ’306 patent does not provide a specific definition of “isolated,” including with respect to a specific protein. EX1001, 17:33-51 (“***Isolated and purified*** protein’ refers to a preparation in which the ***cumulative abundance*** by mass ***of protein components other than the specified protein ... is reduced*** by a factor of 2 or more, ... ***relative to the source material from which the specified protein was isolated***. For clarity, the isolated and purified protein is described as ***isolated and purified relative to its starting material*** (e.g., ***plants*** or other non-animal sources”); 20:32-37 (“The isolated and purified

proteins can be isolated from one or more other components of a non-animal source.

For example, a protein fraction may be isolated from an isolate of a plant.”).

395. Based on my review of the '306 patent, no specific level of purity is required: “In ***some embodiments***, the term “isolated and purified” ***can indicate*** that the preparation of the protein is at least 60% pure, e.g., greater than 65%, 70%, 75%, 80%, 85%, 90%, 95%, or 99% pure.” EX1001, 17:44-47.

396. As a POSITA would understand, soybeans are legumes (plants). EX1001, 18:34-46 (“One of skill in the art will understand that proteins that can be isolated from any organism in the plant kingdom may be used to produce the consumables described herein. Non-limiting examples ***of plant sources include*** ... beans such as, e.g., ***soybeans*** ...”).

397. As explained above (claims 1, 14), Rovaart teaches that the soya bean (soybean) flour used in Rovaart’s Examples contains protein. EX1125, 1:56-63 (teaching a “material rich in protein, for example soya bean flour”). A POSITA would understand that the protein-containing soybean flour had been isolated at least from other components of the “source material” (the soybean itself). For example, soybean flour is typically “defatted,” a process in which the oily fraction is separated from other bean components using conventional techniques. One advantage of defatting the flour is to preserve taste and shelf life, as oil is known to oxidize and become rancid. As the Cho reference explains, for example, (EX1140), [0071]:

By being very low in fat content, the soy protein isolates are very low in polyunsaturated lipid content, which leads to a soy protein isolate with improved flavor. Typically ***lipids present in soy protein isolates, through oxidation and other mechanisms, result in the formation of volatile compounds as described herein that can lead to off-flavors in the resulting soy protein isolate.*** Thus, reducing lipid content improves flavor in the soy protein isolate.

398. Rovaart does not teach a specific level of isolation or purity of plant proteins used in its meat-like food products. However, Rovaart explicitly teaches the use of “defatted” soybean flour in its products. E.g., Example 2, 5:23-25 (“This aqueous solution is added to 1000 g of a defatted soya bean flour...”); Example 4, 6:20-23 (“This solution is added to 1000 g of a defatted soya bean flour...”); Example 5, 6:42-44 (“This solution is added to 500 g of a defatted soya bean flour...”). Accordingly, a POSITA would understand that the proteins in the soybean flour used in Rovaart’s Examples had been ***isolated*** at least from other bean components such as the bean’s fats.

399. To the extent not taught or suggested in Rovaart itself, however, a POSITA would be motivated to isolate the soybean proteins in Rovaart’s soybean flour, e.g., in order to improve flavor and stability of Rovaart’s products. A POSITA would be generally motivated to isolate proteins for use in a foodstuff. Doing so would desirably eliminate components of the source material (soybeans) such as fats/oils that might oxidize and contribute to off-flavors or reduced shelf life. I

discuss this further below in Ground 5 (in combination with the Cho reference). Thus, as protein isolation and purification techniques were known in the art, a POSITA would reasonably expect success achieving this claim.

11. Claims 8, 20

400. In my opinion, claims 8 and 20 are also obvious. For example, claim 8 recites that “**at least one of the one or more isolated plant proteins is purified.**”

401. As explained further above regarding Ground 1 and also claims 7 and 19 above, the '306 patent does not provide a specific definition of “purified.” (EX1001, 20:35-37 (“The isolated proteins may in some cases be *purified, wherein a certain kind of protein is separated from other components found in the non-animal source.*”).) However, as indicated by the patent, an “isolated” protein can *also* be “purified,” indicating a further degree of separation of the protein compared to its source materials.

402. Regarding the **Rovaart** reference, a POSITA would understand that Rovaart’s soybean flour contains proteins separated from (e.g., “*purified*”) at least from other plant components such as the bean’s fats. As explained above (claims 7 and 19 above), Rovaart does not teach, for example, a specific level of purification of its defatted soybean flour relative to the soybean starting material. However, a POSITA would be generally motivated to further purify soybean flour, for example, in order to improve flavor and stability of Rovaart’s products.

403. Accordingly, to the extent not taught or suggested in Rovaart itself, a POSITA would be motivated to purify the isolated proteins in Rovaart's soybean flour. Doing so would desirably eliminate components of the source material such as fats that might oxidize and contribute to off-flavors. I discuss this motivation further below in Ground 5, in which the art provides examples of techniques to purify soy protein isolates (which, like Rovaart's soybean flour, was previously defatted prior to purification) to eliminate undesirable flavors and components. EX1140 (Cho reference). Thus, a POSITA would reasonably expect success achieving this claim.

12. Claims 9, 21, 32

404. In my opinion, claims 9, 21, and 32 are also obvious. For example, claim 9 recites that **“the one or more plant proteins are selected from the group consisting of rubisco, pea proteins, lentil proteins, and other legume proteins.”**

405. As explained above (claims 1, 14, 27, and claims 7 and 19), and as taught in Rovaart, certain Rovaart Example products utilize soybean flour. EX1125, 5:10-25, 6:16-23, 6:29-44. As a POSITA would understand, soybeans are legumes (plants). EX1001, 18:42-46.

406. Rovaart teaches that its soybean flour contains proteins. EX1125, 1:56-62 (disclosing ***“material rich in protein, for example soya bean flour”***). Thus, **Rovaart** teaches the use of legume proteins in its products.

13. Claims 11, 23

407. In my opinion, claims 11 and 23 are also obvious. For example, claim 9 recites that “**the one or more plant proteins are present in the meat replica matrix in an amount of between 1% and 30% (by weight of the meat replica matrix).**”

408. Rovaart teaches that its manufacturing method involves adding “water, the mixture [of all components] containing from 18 to 45% by weight of water.” EX1125, 1:42-47. Accordingly, the dry (non-water) components of the Rovaart method can comprise 55% of the product.

409. The dry components of the Rovaart method include “a finely divided food material,” which includes defatted soybean flour. EX1125, 1:38-43. Rovaart teaches the use of defatted soybean flour in its products (EX1125, 1:56-65):

The expression “finely divided food material” is intended to mean a material in the form of particles of greater or lesser fineness such as a ***plant flour*** or semolina rich in carbohydrates, for example maize starch or rice flour or semolina, or of a ***material rich in protein, for example soya bean flour*** or a product containing proteins of animal or microbial origin. ***Protein-containing materials such as soy flour preferably have a low fat content...***

Rovaart further teaches other ingredients within the “dry” components of its products, specifically the sugar and sulfur compounds for use in the product (EX1125, 2:10-17):

In general, ***it is preferable to use a total quantity of glyco(s) [a term which Rovaart uses to refer to the pentose or hexose, as recited at 1:65-68] and of amino-acid or acids equal to 0.5 to 3% by weight of the dry-matter in the food material***, the molar ratio of glyco to amino-acid (glyco/amino acid) being preferably between 0.5 and 2 to 1, and advantageously at least 1:1.

Accordingly, Rovaart teaches that up to 3.0% of the dry matter of Rovaart product can be the combination of the sugar and sulphur containing amino acids. In that case, the remainder of the “dry” components (e.g., soybean flour) can represent 52% of the Rovaart products (e.g., 55% total dry weight minus 3% of sugar and sulfur compounds).

410. As discussed above (claims 1, 14, 27), specific embodiments of Rovaart’s methods utilize “soya protein flour.” Rovaart does not teach the concentration of plant protein within the soya protein flour, and a POSITA would understand that the levels of protein within the flour could vary due to its method of manufacture. However, a POSITA would understand that the ***flour could comprise approximately 50% protein***.

411. As an example of the levels of protein within defatted soybean flour (as used in Rovaart’s Examples), the U.S. Department of Agriculture’s website provides that “100g” of “Flour, soy, defatted” is “51.1 g,” or 51.1% protein. EX1126, 1 Applying this exemplary proportion of protein to the defatted soybean flour used in the “dry” (non-water) portion of Rovaart’s embodiments, which can be 52% of the

total Rovaart product as explained above, results in a protein content of **about 27%**, **within the claimed range of 1-30%** (e.g., 52% multiplied by 0.511% protein percentage equates to 26.57%).

14. Claims 13, 26, 33

412. In my opinion, claims 13, 26, and 33 are also obvious. For example, claim 13 recites that **“the meat replica matrix is comprised within a consumable product, wherein the consumable product is selected from taco filling, a casserole, a sauce, a topping, soup, stew, and a loaf, wherein, upon cooking of the consumable product, the at least two volatile compounds are generated in substantially higher amounts than upon cooking of the consumable product lacking the meat replica matrix.”**

413. **Rovaart** teaches the preparation of meat-flavored food products with the texture of meat. EX1125, 3:12-16 (“Starting from a substance rich in protein ... the final product has a fibrous structure analogous to the texture of meat and a meat-flavour.”). For example, in making the Example 2 product, an “expanded, fibrous material is obtained,” and this “product ha[s] the flavour of boiled beef and a meat-like texture.” EX1125, 5:29-34. Example 4 also produces “a product with a meat-like texture and the flavour of boiled beef, although slightly less pronounced than that of the product obtained in Example 2.” EX1125, 6:23-28. Similarly, the Example 5 method produces “a material having a meat-like texture and a boiled beef

taste slightly less pronounced than that of the product obtained in Example 2.”

EX1125, 6:48-53.

414. Thus, a POSITA would understand these “analogous” “meat-like” products of Rovaart’s methods could substitute for conventionally-sourced meat, including in the claimed forms of consumables/compositions. EX1125, 3:13-16 (final product has “fibrous structure analogous to the texture of meat”).

415. As a POSITA would recognize, and as discussed further above (claims 1, 14, 27), Rovaart teaches that its plant-based “meat-like” food products comprise Maillard reaction precursors—in particular, “pentoses”/“hexoses” and cysteine—which are well-known in the art to produce volatile compounds associated with beef-like aroma (EX1005, Section V.A-B), including when these precursors are incorporated in “dough” that is heated and extruded using Rovaart’s methods (e.g., Examples 2, 4, and 5).

416. For reasons explained further above (Ground 1, claims 13, 26, 33), a POSITA would understand that cooking a consumable or composition comprising Rovaart’s sugar/sulfur compound-containing product “dough” (e.g., prior to extrusion) would produce “substantially higher” amounts of aroma-associated volatiles than cooking the consumable alone—i.e., “the consumable product lacking the meat replica matrix.”

417. For example, the dough could be combined with other components of a **loaf** (e.g., a meatloaf) which could be heated. The other components of the loaf might also contain Maillard precursors and produce volatile compounds associated with “meat-like” aroma. However, by incorporating Rovaart’s precursor-containing dough into the consumable/composition, a POSITA would understand that heating the consumable as taught in Rovaart would naturally generate “substantially higher” levels of multiple volatile compounds than heating the other components alone.

XV. GROUND 4: ROVAART, CONRAD, PROULX

418. The combination of Rovaart, Conrad, and Crane is obvious as explained above for Ground 3 (Section XIV above, claims 1, 3–9, 11, 13–14, 16–21, 23–24, 26–27, 29–33).

419. For the same reasons explained above in Ground 2 (Section XIII above), it is my opinion that a POSITA would be motivated to substitute **Proulx**’s soybean-sourced leghemoglobin for **Crane**’s recombinant leghemoglobin in each of the challenged claims of Ground 3, with a reasonable expectation of success, and they are therefore obvious.

XVI. GROUND 5: ROVAART, CONRAD, CRANE/PROULX, CHO

420. In my opinion, claims 7–8 and 19–20 of the ’306 patent are obvious over Rovaart in view of Conrad, either Crane or Proulx, and Cho. The combination

of Rovaart and Conrad with either Crane or Proulx is obvious as explained above in Grounds 3–4. §§VIII-IX, *supra*.

421. **Cho**, titled “Bland Tasting Soy Protein Isolate and Processes for Making Same,” is in the same field of endeavor as the ’306 patent and reasonably pertinent to the problem facing the ’306 patent’s named inventors at least because Cho teaches methods of preparing improved plant (soy)-based foodstuffs described in further detail below. Thus, Cho, like Rovaart, Conrad, and Crane/Proulx, is analogous art to the ’306 patent.

422. A POSITA would be motivated to combine Cho with Rovaart, Conrad, and Crane/Proulx because, as discussed further above for claims 1, 14, and 27, Rovaart’s “meat-like” products comprise soybean flour for use in a foodstuff (for example Examples 2, 4, and 5), which, as taught in Cho, could be further processed to obtain a better-tasting flour that would render the Rovaart products better tasting. As explained below, a POSITA would have a reasonable expectation of success in doing so because Cho teaches methods for extracting (isolating) and further purifying soybean proteins for this purpose.

423. As a POSITA would understand (see Ground 3, claims 7 and 19), soybean flour is “isolated” in that it is separated from other components of the soybean. In my experience, for example, soy flour is typically defatted (the fat is removed using solvents), because fat can oxidize over time and cause rancidity. In

describing a solution to this problem in the art, Cho's methods "relate[] to bland tasting soy protein isolates having excellent functional characteristics and containing **very low levels of volatile compounds that can negatively affect flavor characteristics.**" EX1140, [0001].

424. Cho teaches various motivations to use its isolation and purification methods. Cho provides, for example, (EX1140 [0004]), that:

Despite all of the above advantages that soy proteins provide, it is well known that by supplementing foods with increased levels of dietary fiber and soy protein, taste can be seriously compromised. More particularly, **protein sources, such as soy protein, can produce objectionable off-flavors in the finished products.** For example, many consumers complain that **high protein foods, like those supplemented with soy protein, taste grassy, beany, and bitter.** Soy off-flavors may be responsible for most of the complaints with respect to the taste of soy-based products.

425. Cho attributes these negative properties to the oxidation of lipids (e.g., fats and oils) (EX1140, [0005]):

It is believed that the **development of soy off flavors is initiated when phospholipids and triglycerides undergo hydrolysis to yield polyunsaturated free fatty acids, which then react with molecular oxygen to form fatty acid hydroperoxides and other oxygenated lipid species.** Both the hydrolysis and the oxidation can occur in enzyme-catalyzed and in non-enzyme-catalyzed reactions. The hydroperoxides

then decompose into smaller molecules such as aldehydes and ketones and ***it is these small molecules that are responsible for the odor and flavor of vegetable oil-based products.***

426. Accordingly, to avoid these problems of objectionable “off flavor” development, Cho teaches that isolating and purifying soy proteins for use in foodstuffs improves flavor by creating “bland” soy protein. EX1140, [0004]–[0014]; *see id.* [0013] (“The soy protein isolate is suitable for use in a number of foods...”). Cho teaches that using these “bland” protein isolates are “highly desirable” in foodstuffs (EX1140, [0060]):

The ***soy protein isolates derived from the processes described above*** are highly functional ***in foods*** and drink products and ***present a bland taste, which is highly desirable*** as noted herein.

427. A POSITA would therefore be motivated to utilize Cho’s teachings in preparing Rovaart’s products, e.g., by reducing the “beany” qualities of soybean flour used in Rovaart’s products that could negatively impact the products’ desired meaty flavor.

A. **Claims**

1. **Claims 7, 19**

428. In my opinion, claims 7 and 19 are obvious. For example, claim 7 recites, “at least one of the one or more plant proteins is isolated.”

429. Cho teaches isolating soy (plant) proteins, which a POSITA would understand involve conventional techniques to extract the proteins from the bean and remove the fats (e.g., “defatting”) (EX1140, [0006]):

The conventional process for manufacturing soy protein isolate begins with the production of a full fat soy flake from the bean, which is substantially defatted with hexane. This process typically removes more than 80% of the acid hydrolysable lipids in the soy flake, as measured by AOAC Method 922.06. The majority of the lipids remaining in the extracted flake are phospholipids. *Soy protein is then extracted from the defatted soy flour with water and separated from the insoluble vegetable matter* using centrifugation. The *extracted protein is precipitated, washed, resuspended in water and spray dried* as described, for example, in Hettiarachchy, et al., Soybeans: Chemistry, Technology, and Utilization, pp. 379-411, Aspen Publishers (1997), which is incorporated herein by reference in its entirety.

Cho describes this “well-known” technique as the “first step” in its processes.

The processes of the present disclosure for producing bland-tasting highly functional soy protein isolates include a number of steps. In *the first step of the process, a soy protein concentrate prepared by aqueous ethanol extraction* is hydrated with water to produce a suitable dispersion. A suitable soy protein concentrate prepared by aqueous ethanol extraction for use as a starting material in the processes of the present disclosure can be obtained by processing a soy protein source, such as soy flakes, by an extraction process using aqueous alcohol. Extraction processes for forming soy protein concentrates are

well known and disclosed, for example, in U.S. Pat. No. 6,187,367, issued to Cho, et al. (Feb. 13, 2001) and U.S. Pat. No. 6,132,795, issued to Holbrook, et al. (Oct. 17, 2000).

EX1140, [0037].

One extraction process suitable for preparing a dry soy protein concentrate for use in the processes described herein includes obtaining a defatted Soy flake material using the method discussed herein above. The defatted soy flake material may then be put through a solvent extraction process. Typically, the solvent for the extraction process is an aqueous alcohol. The aqueous alcohol extraction removes materials soluble therein, including a substantial portion of the isoflavones and carbohydrates. This produces a protein concentrate material that contains from about 65% to about 85% protein by weight on a dry basis, but which is significantly reduced in isoflavones concentration.

EX1140, [0038].

Alcohol extraction to remove alcohol soluble components from the protein is particularly preferred in the solvent extraction process since alcohol extraction generally produces a better tasting soy protein material compared to aqueous acid extraction.

EX1140, [0039].

2. Claims 8, 20

430. In my opinion, claims 8 and 20 are obvious. For example, claim 8 recites “at least one of the one or more isolated plant proteins is purified.” Cho

further teaches purifying soy proteins, e.g., to further reduce undesirable bean-associated aromas.

431. Cho teaches that, even using conventional protein isolation techniques, “[a]ppreciable quantities of the flavor-active volatiles ... may continue through the subsequent protein isolation steps to result in a soy protein isolate with the familiar grassy, beany flavors.” EX1140, [0007]. Thus, Cho teaches additional purification steps including “re-solubiliz[ing],” “heating,” precipitating, and neutralizing soy protein isolate “slurr[ies].” EX1140,, [0011]–[0014]. This method yields a purified soy protein isolate (for example, EX1140, [0015]–[0016] and [0029], also [0017]–[0028], [0030]):

The present disclosure is further directed to ***a soy protein isolate comprising a total fat content*** as measured by acid hydrolysis ***of less than about 3%, a total isoflavones content of less than about 200 ppm, a total potassium content of less than about 7500 ppm, and a nitrogen solubility index of at least about 60%.***

The present disclosure is further directed to ***a soy protein isolate comprising a total fat content*** as measured by acid hydrolysis ***of less than about 3% and a total isoflavones content of less than about 50 ppm.***

The present invention is further directed to a soy protein isolate comprising a total isoflavones content of less than about 200 ppm, a

total potassium content of less than about 7500 ppm, and a nitrogen solubility index of at least about 70%, wherein the soy protein isolate is prepared from a process comprising first hydrating with water a soy protein concentrate prepared by aqueous ethanol extraction to produce a dispersion and heating the dispersion to a temperature of at least about 125° C. and holding the dispersion at that temperature for a period of at least about 5 seconds to about 30 seconds to produce a slurry. The slurry is then separated to produce a supernatant, the pH of which is adjusted with an acid to form a precipitate. The precipitate is separated and washed with water and then hydrated to form a hydrated precipitate slurry. ...

432. Cho teaches that these processes “produc[e] soy protein isolates having excellent functionality and presenting a bland [non-objectionable] taste.” EX1140, [0011], [0033].

XVII.GROUND 6: CONRAD, MOTTRAM, CRANE/PROULX, CHO

433. For reasons I explain further above for Grounds 1-2 (Sections XII; XIII), it is my opinion that the combinations of Conrad, Mottram, and Crane/Proulx are obvious.

434. Moreover, for the same reasons explained above in Ground 5 regarding claims 7–8 and 19–20, a POSITA would be motivated to utilize **Cho**’s teachings to prepare the grain meat of Conrad, and would reasonably expect success doing so; thus, it is my opinion that these claims are obvious. Although Conrad discloses preparations of its meat replacement products using “grain meat” obtained from

whole grains, rather than soybeans, a POSITA would understand that the isolation and purification principles taught in Cho are relevant for the preparation of Conrad's grain meat and, in particular, for the purification of plant proteins such as gluten for use in Conrad's replicas.

435. As discussed further above for claims 1, 14, and 27, Conrad teaches a method for isolating and purifying plant proteins for use in its meat replacement products, for example, by forming a "starch slurry" that separates soluble proteins, salts, and sugars, from an insoluble gluten/bran fraction obtained from the whole grain. As reflected in Table 1 below (highlighting added), Conrad teaches that oil (fat) is retained in the course of preparing the "wheat meat," for example 2.5% of the Table 1 "wheat meat" comprises "wheat germ oil":

TABLE 1			
Compound	Meat		
	Beef	Swine	Wheat meat
Water	73%	65%	65%
Starch	0%	0%	3%
Bran-fiber	0%	0%	14%
Proteins	22	19%	15%
Fat	3%	12%	0%
Wheat germ incl.	0%	0%	2.5%
wheat germ oil			
Salts	2%	4%	0.5%
	100%	100%	100%

436. A POSITA understand that the wheat germ oil remaining in Conrad's "wheat meat" could undesirably contribute to the flavor of Conrad's meat replicas (e.g., by becoming oxidized and rancid) and reduce its shelf-life. Using conventional

techniques, including those disclosed in Cho (Ground 5 above), a POSITA therefore would be motivated to further isolate and purify Conrad's wheat (plant) gluten proteins. Using methods such as Cho's, a POSITA would understand it would be feasible to eliminate objectionable flavors or unwanted components in the whole grain—which could detract from the desired “meat-like” properties of Conrad's replica—with a reasonable expectation of success.

XVIII. GROUND 7: CONRAD, MOTTRAM, CRANE/PROULX, BOYE

437. In my opinion, claims 9–10, 21–22, and 32 of the '306 patent are obvious over Conrad in view of Mottram, either Crane or Proulx, and Boye. The combination of Conrad and Mottram with either Crane or Proulx is obvious as explained above in Grounds 1–2 (Sections XII; XIII above).

438. As explained further below, **Boye** teaches that the inclusion of pea proteins (and specifically pea albumins) in foodstuffs including by substituting for real meat in meat foodstuffs, can provide a variety of nutritional, health, and societal benefits (e.g., by addressing malnutrition and food insecurity). Boye is therefore in the same field of endeavor of the '306 patent and reasonably pertinent to the problem facing its named inventors, and is analogous art.

439. A POSITA would be motivated to combine Boye with Conrad, Mottram, and Crane/Proulx, because, as provided below, Boye teaches advantages of utilizing pea proteins, specifically pea albumins, in meat-substitute foodstuffs,

“especially when blended with cereal[grain] proteins” as taught in Conrad. EX1016, Abstract. A POSITA would therefore be motivated to utilize pea proteins, including pea albumins, in the grain-based meat replica of Conrad, with a reasonable expectation of success.

A. **Claims**

1. **Claims 9, 21, 32**

440. In my opinion, claims 9, 21, and 32 are obvious. For example, claim 9 recites that “the one or more plant proteins are selected from the group consisting of rubisco, pea proteins, lentil proteins, and other legume proteins.”

441. A POSITA would be motivated to combine Conrad’s methods with the teachings of **Boye** regarding pea proteins, with a reasonable expectation of success, because Boye teaches that pea proteins are a desirable alternative source for the protein used in Conrad’s “grain meat.”

442. Specifically, Boye teaches that “[p]ulses *constitute an important source of dietary protein* for large segments of the world’s population particularly in those countries in which the consumption of animal protein is limited by nonavailability or is self-imposed because of religious or cultural habits.” EX1016, 415. Boye further suggests combining pea proteins with Conrad’s grain meat because it provides that “[t]he potential for *blending pulses such as pea ... with*

other locally grown grains to meet some of the protein malnutrition problem worldwide is ... of ***tremendous interest***.” EX1016, 415.

443. Boye teaches that pea proteins are nutritious (EX1016, Abstract):

Pulses (*pea*, chickpea, lentil, bean) ***are an important source of food proteins. They contain high amounts of lysine, leucine, aspartic acid, glutamic acid and arginine and provide well balanced essential amino acid profiles*** when consumed with cereals and other foods rich in sulphur-containing amino acids and tryptophan. The protein content of most pulse legumes fall within the range of 17–30% (d.w.b.) [dry weight basis].

Additionally, according to Boye (EX1016, Abstract), pea proteins are useful in food products for their “functional” properties, which would be useful in Conrad’s meat replacement products:

Apart from their nutritional properties, pulse proteins also possess functional properties that play an important role in food formulation and processing. Examples of such functional properties include solubility, water and fat binding capacity and foaming. Various research studies indicate that some functional properties of pulse proteins may be comparable to those of other frequently used proteins such as soy and whey. ***The functional properties of pulse proteins have been exploited in the preparation and development of products*** such as bakery products, soups, extruded products and ready to eat snacks.

Boye further teaches the “health benefits” of using pulses (peas) in foodstuffs, and the availability of techniques for doing so, including to address worldwide problems of malnutrition and food insecurity (EX1016, Abstract).

The growing body of research on the health benefits associated with the consumption of pulses has increased interest in developing innovative technologies to expand the use of pulses in food products.

At the same time, ***there are growing global food security challenges and protein malnutrition continues to be a problem in many countries around the world. Pulses***, especially when blended with cereal proteins, ***may offer a promising alternative source for nutritional and functional proteins.*** This review provides an overview of the characteristics of pulse proteins, current and emerging techniques for their fractionation, their major functional properties and opportunities for their use in various applications.

EX1016, Abstract.

444. Boye discloses a variety of “current and emerging food application opportunities for pulses and their protein fractions,” including as meat substitutes. EX1016, 424.

445. In particular, Boye teaches that “[p]***ulse flours and fractions have been used successfully as ingredients in the formulation of meat products*** (e.g., burgers, sausages, nuggets, etc.),” and that using ***cowpeas “increased the protein content of the meatballs or comminuted meat products.”*** EX1016, 425. Thus, similar to the teachings of Conrad, Boye teaches using pea (pulse) proteins in products comprising

real meat, which would help improve the “availability” of meat-like food products for consumers (a problem with real meat, as taught in Boye, see page 415) as well as to increase the protein content of such meat products.

2. Claims 10, 22

446. In my opinion, claims 10 and 22, which depend from claims 9 and 21 respectively, are obvious. For example, claim 10 recites that “the pea proteins comprise pea albumin proteins.”

447. Boye teaches specific advantages of using pea albumins in foodstuffs (such as Conrad’s meat replacement products). Boye teaches that pea albumins “represent[] 15–25% ... of the total [pea] protein” (EX1016, 417) and provide certain nutritional benefits over other kinds of pea proteins, such as globulins. For example, Boye discloses that “*pea albumin was a superior source of another essential amino acid, tryptophan,*” and, “[c]ompared to the globulins, *pea albumins contain more of the essential amino acids tryptophan, lysine, threonine, cysteine and methionine.*” EX1016, 416, 417–418.

XIX. GROUND 8: ROVAART, CONRAD, CRANE/PROULX, BOYE

448. In my opinion, and as set forth further above (Section XVIII), claims 9–10, 21–22, and 32 of the ’306 patent are obvious over Rovaart in view of Conrad, either Crane or Proulx, and Boye. The combination of Rovaart and Conrad with either Crane or Proulx is obvious as explained above in Grounds 3–4.

449. As explained in greater detail above for Ground 7, a POSITA would be motivated to combine Boye's pea proteins (and specifically its pea albumins) with Rovaart, Conrad, and Crane/Proulx with a reasonable expectation of success. As discussed above, for the same reasons that a POSITA would be motivated to use pea proteins—specifically, pea albumins—in foodstuffs such as Conrad's meat replacement products, Boye teaches nutritional advantages of utilizing pea proteins (pea albumins), in meat analogs such as Rovaart's plant-based “meat-like” food product.

450. For example, according to Boye (EX1016, Abstract), pea proteins are useful in food products for their “functional” properties, which are useful in products such as “extruded” products (e.g., the “meat-like” food products taught in Rovaart), in the same way they are useful for Conrad's meat replacement products:

Apart from their nutritional properties, pulse proteins also possess functional properties that play an important role in food formulation and processing. Examples of such functional properties include solubility, water and fat binding capacity and foaming. Various research studies indicate that some functional properties of pulse proteins may be comparable to those of other frequently used proteins such as soy and whey. ***The functional properties of pulse proteins have been exploited in the preparation and development of products such as bakery products, soups, extruded products and ready to eat snacks.***

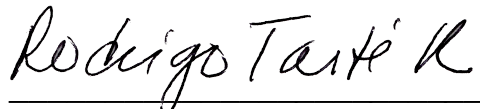
**XX. NO SECONDARY CONSIDERATIONS OF NON-OBVIOUSNESS
SUPPORT PATENTABILITY OF THE CHALLENGED CLAIMS**

451. I understand that Motif's expert Dr. Robert McGorin is offering opinions regarding "secondary considerations of non-obviousness" of the Challenged Claims. I have reviewed the McGorin Declaration and rely on Dr. McGorin's opinions therein.

XXI. CONCLUSION

452. In signing this Declaration, I recognize that the Declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I also recognize that I may be subject to cross-examination in the case and that cross-examination will take place within the United States. If cross-examination is required of me, I will appear for cross-examination within the United States during the time allotted for cross-examination.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on the information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.



Rodrigo Tarté, Ph.D.

Dec. 7, 2022

Date