

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

MOTIF FOODWORKS, INC.,

Petitioner,

v.

IMPOSSIBLE FOODS INC.,
Patent Owner.

Case No.: IPR2023-00207
U.S. Patent No. 11,224,241

**DECLARATION OF DR. TARTÉ
IN SUPPORT OF PETITION FOR *INTER PARTES* REVIEW**

TABLE OF CONTENTS

	<u>Page</u>
I. INTRODUCTION	1
II. Qualifications.....	2
III. SCOPE OF ASSIGNMENT	5
IV. LEGAL UNDERSTANDING	7
A. Person of Ordinary Skill in the Art	7
B. Claim Construction	8
C. Anticipation	9
D. Obviousness.....	10
E. Product-by-process Claims	11
F. Written Description	12
V. THE '241 PATENT	13
A. Level of Ordinary Skill In The Art	13
B. Claims.....	13
C. Prosecution History for the '241 Patent	14
D. Priority Date of the '241 Patent.....	19
VI. CHALLENGED CLAIMS	20
VII. STATE OF THE ART	28
A. Benefits of Artificial Meat Flavor Additives and Meat Substitutes	28
1. Meat Consumption.....	28
2. Health Benefits.....	29
3. Environmental Benefits	30
4. Animal Welfare.....	31
B. Attributes of Meat	32
1. Nutritional Content of Meat.....	33
2. Color of Meat	35
3. Non-animal Heme-Containing Proteins.....	37

C.	Recombinant Technology	39
D.	Meat Flavor Chemistry.....	40
VIII.	SUMMARY OF THE PRIOR ART	40
A.	“Brown” – EX1012	40
B.	“Rovaart” – EX1125	43
C.	“Ronai” – EX1132.....	43
D.	“MacLeod” – EX1024.....	44
E.	“Giacino” – EX1015	45
F.	“Conrad” - EX1013	46
G.	“Crane” – EX1014.....	46
H.	“Proulx” – EX1019	47
I.	“Rolan” – EX1021.....	49
IX.	SUMMARY OF OPINIONS.....	50
X.	CLAIM CONSTRUCTION	51
A.	“wherein the meat-like food product is free of animal heme- containing protein”	52
B.	The process limitations lack patentable weight	53
C.	“a compound”.....	60
XI.	FOUNDATIONS 1A, 1B, 1C: BROWN, GIACINO, RONAI, ROLAN	61
A.	Ground 1A (Brown, Giacino).....	62
1.	Claim 1	62
2.	Claim 2.....	83
3.	Claim 3.....	84
4.	Claim 4.....	85
5.	Claim 5.....	85
6.	Claim 6.....	85
7.	Claim 7.....	85
8.	Claims 8-9	89
9.	Claim 12.....	93

10.	Claim 13	93
11.	Claim 14	94
12.	Claim 15	99
13.	Claim 16	100
14.	Claims 17, 18, and 19	100
15.	Claim 20	101
16.	Claim 21	103
17.	Claim 22	103
18.	Claim 23	105
B.	Ground 1B (Brown, Giacino, Ronai)	106
C.	Ground 1C (Brown, Giacino, Rolan)	109
XII.	FOUNDATIONS 2A-2D: ROVAART, CONRAD, CRANE, RONAI, GIACINO, ROLAN.....	112
A.	Ground 2A (Rovaart, Conrad, Crane)	112
2.	1[pre]: A meat-like-food product produced by a method comprising:.....	113
3.	1[a]: providing one or more plant proteins	113
4.	1[b]: combining, with the one or more plant proteins: a composition comprising a heme-containing protein, wherein the composition comprises at least 60% of the heme-containing protein on a dry weight basis	114
5.	1[c]: a compound selected from glucose, ribose, fructose, lactose, xylose, arabinose, glucose-6-phosphate, maltose, and galactose, and mixtures of two or more thereof; and.....	134
6.	1[d]: a compound selected from cysteine, cystine, thiamine, methionine, and mixtures of two or more thereof in a concentration of at least 1.5 mM;	135
7.	1[e]: wherein the meat-like food product is free of animal heme-containing protein;	136
8.	1[f]: wherein cooking the meat-like-food-product results in the production of at least two volatile compounds which have a meat-associated aroma; and.....	138

9.	1[g]: wherein the meat-like food product is in a form selected from the group consisting of a hotdog, a burger, ground meat, a sausage, a steak, a filet, a roast, a meatball, a meatloaf, or bacon.	140
10.	Claim 4	142
11.	Claim 5	142
12.	Claim 6	143
13.	Claim 8	144
14.	Claim 10	144
15.	Claim 13	145
16.	Claim 14	145
17.	Claims 15 and 16	147
18.	Claims 17, 18, and 19	148
19.	Claim 20	149
20.	Claim 21	151
21.	22[pre]: A meat-like-food product produced by a method comprising:	151
22.	22[a]: providing one or more plant proteins; and	151
23.	22[b]: combining, with the one or more plant proteins: a heme-containing protein	152
24.	22[c]: one or more of glucose, ribose, fructose, lactose, xylose, arabinose, glucose-6-phosphate, maltose, and galactose; and	152
25.	22[d]: one or more of cysteine, cystine, thiamine, and methionine;	152
26.	22[e]: wherein the meat-like food product is free of animal heme-containing protein;	152
27.	22[f]: wherein cooking the meat-like-food-product results in the production of at least two volatile compounds which have a meat-associated aroma; and	153
28.	22[g]: wherein the meat-like food product is in a form selected from the group consisting of a hotdog, a burger,	

	ground meat, a sausage, a steak, a filet, a roast, a meatball, a meatloaf, or bacon.....	153
29.	Claim 23	153
B.	Ground 2B: Rovaart, Conrad, Crane, Ronai	154
C.	Ground 2C: Rovaart, Conrad, Crane, Giacino	155
D.	Ground 2D: Rovaart, Conrad, Crane, Rolan	157
XIII.	GROUND 3A-3D: ROVAART, CONRAD, PROULX, RONAI, GIACINO, ROLAN.....	159
A.	Proulx is Analogous Art.....	160
B.	A POSITA Would Have Been Motivated to Combine Rovaart, Conrad, and Proulx to Achieve the Claimed Subject Matter.....	160
C.	A POSITA Would Have Had a Reasonable Expectation of Success When Combining Rovaart, Conrad, and Proulx.....	166
D.	Ground 3A: Rovaart, Conrad, Proulx	167
1.	Claim 1	167
2.	Claims 4-5	169
3.	Claim 6.....	169
4.	Claim 7.....	170
5.	Claims 8, 10, 13-21	170
6.	Claims 22-23	170
E.	Ground 3B: Rovaart, Conrad, Proulx, Ronai	170
F.	Ground 3C: Rovaart, Conrad, Proulx, Giacino	171
G.	Ground 3D: Rovaart, Conrad, Proulx, Perret.....	171
XIV.	Conclusion	171

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

I. INTRODUCTION

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 1-23 (the “Challenged Claims”) of U.S. Patent No. 11,224,241 (the “’241 patent”). Based on the first page of the ’241 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 ’241 patent claims in this declaration (“Declaration”).

3. I am informed that the ’241 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 ’241

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 '241 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 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. SCOPE OF ASSIGNMENT

14. In forming my opinions regarding the validity of the '241 patent, I have considered the '241 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 '241 patent's earliest possible priority date. I have also reviewed the prosecution (the "file history") of the '241 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 '241 patent.

16. I have also relied on my personal knowledge, education, training, and professional experience in order to form my opinions concerning the '241 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.

20. Throughout this Declaration, I refer to specific pages of the '241 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 UNDERSTANDING

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. Anticipation

31. I am informed that a patent claim is anticipated when a single piece of prior art describes every element of the claimed invention, either expressly or inherently, arranged in the same way as in the claim. For inherent anticipation to be found, it is required that the missing descriptive material is necessarily present in the prior art. I am informed that, for the purpose of an *inter partes* review, prior art that anticipates a claim can include both patents and printed publications from anywhere in the world.

32. I am further informed that when a patent claims a range, that range is anticipated by a prior art reference if the reference discloses a point within the range. I understand that, if the prior art discloses its own range, rather than a specific point, then the prior art is only anticipatory if it describes the claimed range with sufficient specificity such that a reasonable fact finder could conclude that there is no reasonable difference in how the invention operates over the ranges.

D. Obviousness

33. I am informed that a patent claim is unpatentable and invalid if the subject matter of the claim as a whole would have been obvious to a person of ordinary skill in the art of the claimed subject matter as of the time of the invention at issue. I am informed 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, if any, between each claim of the patent and the prior art; and (3) the level of ordinary skill in the art at the time the patent was filed. Unlike anticipation, which allows consideration of only one item of prior art, I am informed that obviousness may be shown by considering more than one item of prior art. Moreover, I understand that when the prior art discloses a range, rather than a point, the court must evaluate whether the patentee has established that the claimed range is critical to the operability of the claimed invention.

34. Moreover, I understand that objective indicia of non-obviousness, also known as “secondary considerations,” like the following are also to be considered when assessing obviousness: (1) commercial success; (2) long-felt but unresolved needs; (3) copying of the invention by others in the field; (4) initial expressions of disbelief by experts in the field; (5) failure of others to solve the problem that the inventor solved; and (6) unexpected results. I also understand that evidence of objective indicia of non-obviousness must have a nexus with the claimed subject matter.

E. Product-by-process Claims

35. I have been informed by counsel that claims 1 and 22 are product-by-process claims. I have been further informed by counsel that although a product-by-process claim is limited by and defined by the process recited in the claim, determination of *patentability* is based on the product itself. Moreover, the patentability of a product does not depend on its *method* of production. Thus, I understand that if the product in the product-by-process claim is the same as or obvious from a product of the prior art, the claim is unpatentable even though the prior product was made by a different process. However, I have also been informed that if the process by which a product is made imparts structural and functional differences distinguishing the claimed product from the prior art, then those

differences are relevant as evidence of no anticipation of the patent's product-by-process claim, although they are not explicitly part of the claim.

F. Written Description

36. I understand that a patent's specification is required to contain a written description of the invention. I am informed that the test for whether the written description is adequate is whether the disclosure of the application relied upon reasonably conveys to those skilled in the art that the inventor had "possession" of the claimed subject matter as of the filing date. I am informed and understand that this inquiry is a factual question and requires an objective inquiry into the specification from the perspective of a POSITA. I further understand that demonstrating adequate written description requires a precise definition of the invention. Relatedly, I understand it is not enough for purposes of the written description support that the disclosure, when combined with the knowledge in the art, would lead one to speculate as to the modifications that the inventor might have envisioned, but did not disclose. Moreover, when a range of values is claimed in a patent claim, I understand that a skilled artisan must be able to reasonably discern a disclosure of that range in the specification to satisfy the written description requirement.

V. THE '241 PATENT

A. Level of Ordinary Skill In The Art

37. The '241 patent is directed to the art of food science and recombinant protein expression arts. A POSITA would have a Bachelor of Science degree in food science, biology, chemistry, microbiology, or a related discipline. A POSITA would also have a Master of Science degree or Ph.D. in food science or at least three years of experience working as a food scientist. A POSITA could also be part of a team of food scientists, including flavor chemists. As explained above I exceed all of these requirements. My opinions expressed herein are from the perspective of a POSITA.

B. Claims

38. The '241 patent contains 23 claims, two independent and 21 dependent claims. I understand that a dependent claim contains all the elements of the independent claim it depends on, in addition to the elements recited in the dependent claims.

39. Claim 1 is representative and reproduced below.

A meat-like-food product produced by a method comprising:

providing one or more plant proteins; and

combining, with the one or more plant proteins:

a composition comprising a heme-containing protein, wherein the composition comprises at least 60% of the heme-containing protein on a dry weight basis;

a compound selected from glucose, ribose, fructose, lactose, xylose, arabinose, glucose-6-phosphate, maltose, and galactose, and mixtures of two or more thereof; and

a compound selected from cysteine, cystine, thiamine, methionine, and mixtures of two or more thereof in a concentration of at least 1.5 mM;

wherein the meat-like food product is free of animal heme-containing protein;

wherein cooking the meat-like-food-product results in the production of at least two volatile compounds which have a meat-associated aroma; and

wherein the meat-like food product is in a form selected from the group consisting of a hotdog, a burger, ground meat, a sausage, a steak, a filet, a roast, a meatball, a meatloaf, or bacon.

C. Prosecution History for the '241 Patent

40. Based on my review of the first page of the '241 patent (EX Patent), I see that U.S. Application No. 15/913,090 (the "'090 application") was filed on March 6, 2018, and issued as the '241 patent on January 18, 2022. I understand that the '241 patent is a continuation of U.S. Application No. 15/398,479, filed on January 4, 2017 (now U.S. Patent No. 9,943,096), which is a continuation of U.S. Application No. 14/797,006 filed on July 10, 2015, (now U.S. Patent No. 9,700,067), which is a continuation-in-part of Application No. PCT/US2014/011347, filed January 13, 2014, which is a continuation of Application No. 13/941,211, filed July 12, 2013, which claims the benefit of priority of U.S. Provisional Application No.

61/908,634 (the “’634 provisional application”), filed November 25 12, 2013, and U.S. Provisional Application No. 61/751,816, filed January 11, 2013. For the purpose of my analysis in this Declaration, I have assumed filed January 11, 2013, as the priority date for the Challenged Claims.

41. I have reviewed portions of the prosecution history of the ’090 application. Before issuing as the ’241 patent, the ’090 application went through two rounds of rejections. *See generally* EX1150 (May 12, 2020, Non-Final Rejection); EX1150 (Feb. 08, 2021, Final Rejection).

42. The initial ’090 application included one independent claim and 22 dependent claims. The claims as originally filed included the terms “a source of heme-containing protein.” EX1150(Mar. 13, 2018, Claims). Claim 31 is representative and originally filed as:

Claim 1: A meat-like-food product produced by a method comprising: providing one or more plant proteins; and combining, with the one or more plant proteins: **a source of a heme-containing protein**, wherein the source of the heme-containing protein comprises at least 60% of the heme-containing protein on a dry weight basis;

a compound selected from glucose, ribose, fructose, lactose, xylose, arabinose, glucose-6-phosphate, maltose, and galactose, and mixtures of two or more thereof;

and a compound selected from cysteine, cystine, thiamine, methionine, and mixtures of two or more thereof in a concentration of at least 1.5 mM;

wherein cooking the meat-like food product results in the production of at least two volatile compounds.

Id. (emphasis added).

43. The Examiner rejected pending claims 31-53 in the first Non-final office action on September 17, 2015. *See generally* EX1150 (May 12, 2020, Non-Final Rejection). Claims 31-53 were rejected for failing to comply with the written description requirement. EX1150 (May 12, 2020, Non-Final Rejection). The Examiner explained that the “present specification uses the term ‘meat-like’ to describe the flavors produced upon cooking” without providing a “description of a ‘meat-like’ food product. *Id.*

44. In that office action, claims 31-50 also were rejected for indefiniteness. EX1150(May 12, 2020, Non-Final Rejection) at 4. The examiner concluded that “the term ‘meat-like food product’ renders the claim indefinite.” *Id.* The Examiner explained that “it is not clear what properties define a ‘meat-like food product.’” *Id.*

45. The Examiner further rejected claims 31-53 as unpatentable over Hseih et al. in view of Proulx. EX1150(May 12, 2020, Non-Final Rejection). The Proulx reference teaches using the heme iron-containing protein, leghemoglobin, which is isolated from soybean root nodules to fortify foods, such as tortillas, with heme iron. EX1019(Proulx) at Abstract. Proulx also describes “iron deficiency as a major national problem, affecting over 2 billion people” and teaches fortifying food with “heme iron,” a more biologically available iron, as a solution to this problem. EX1019(Proulx) at 1.

46. Hseih discloses a process of 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, and wherein the mixture comprises: (a) dry ingredients that comprise: (i) a protein component that comprises a plant derived protein material, wherein the protein component is at an amount that is no more than about 90% by weight of the dry ingredients; (ii) a carbohydrate component at an amount that is in the range of about 2 to about 50% by weight of the dry ingredients; and (iii) a lipid component at an amount that is in the range of about 0.1 to about 5% by weight of the dry ingredients; and (b) wet ingredients that comprise water. EX1150(May 12, 2020, Non-Final Rejection) at 5.

47. The Examiner explained that it would have been obvious to one of ordinary skill in the art to have fortified the structured plant protein of Hseih et al. with leghemoglobin from soy root nodules, to obtain a product with improved nutritional status, i.e., bioavailable source of iron. EX1150(May 12, 2020, Non-Final Rejection) at 7.

48. With respect to claim 37, the Examiner concluded that “modified Hsieh discloses all of the claim limitations.” Given Proulx teaches a heme-containing protein (leghemoglobin) from soy root nodules, “intrinsically the plant heme-containing protein would comprise an amino acid sequence at least 80% sequence

identity to a polypeptide set forth in SEQ ID NO: 1-26.” EX1150(May 12, 2020, Non-Final Rejection) at 8.

49. The Examiner rejected claims 42-48 because “modified Hseih et al. discloses all of the claim limitations.” *Id.* The Examiner explained that “the structured plant protein product may comprise flavoring agents such as an animal meat flavor, yeast extract, hydrolyzed proteins, glutamic acid salts, guanylic salts ... and lipids such as corn oil, palm oil, and cottonseed oil.” *Id.*

50. Regarding claims 47 and 48, the Examiner explained that “[g]iven Hseih et al. discloses a structured plant protein product comprising animal meat, including beef, it necessarily follows that the product would display the raw and cooked color properties.” *Id.*

51. On November 12, the applicant amended claim 31 to include “wherein the heme-containing protein is free of animal heme-containing proteins.” 1150(Nov. 20, 2020, Final Rejection) at 6.

52. On February 08, 2021, the Examiner issued a Final Rejection—reiterating the basis for rejection from the Non-Final Rejection. *See generally* EX1150(Feb. 08, 2021, Final Rejection).

53. On April 8, 2021, the applicant amended the claims and rearranged the terms to read as follows:

A meat-like-food product produced by a method comprising: providing one or more plant proteins; and combining, with the one or more plant

proteins: a composition comprising a heme-containing protein, wherein the composition comprises at least 60% of the heme-containing protein on a dry weight basis; a compound selected from glucose, ribose, fructose, lactose, xylose, arabinose, glucose-6-phosphate, maltose, and galactose, and mixtures of two or more thereof; and a compound selected from cysteine, cystine, thiamine, methionine, and mixtures of two or more thereof in a concentration of at least 1.5 mM; wherein the meat-like food product is free of animal heme-containing protein; wherein cooking the meat-like-food-product results in the production of at least two volatile compounds which have a meat-associated aroma; and wherein the meat-like food product is in a form selected from the group consisting of a hotdog, a burger, ground meat, a sausage, a steak, a filet, a roast, a meatball, a meatloaf, or bacon.

EX1150(Apr. 08, 2021, Claims).

54. In particular, the applicant amended the “free of animal heme-containing protein” limitation to specify that it is the “meat-like food product” that is “free of animal heme-containing protein.” The applicant argued that such an amendment would foreclose the examiner’s use of Hsieh’s plant protein product comprising animal meat combined with Proulx’s non-animal heme-containing protein, as animal meat contains animal heme-containing proteins.

55. After amendment, the Examiner issued a Notice of Allowance on April, 27, 2021. EX1150(Apr. 27, 2021, Notice of Allowance).

D. Priority Date of the ’241 Patent

56. I understand that Motif’s expert Dr. Robert McGorin is offering an opinion that U.S. Provisional Application No. 61/751,816 (the “’816 Provisional”) fails to provide adequate support for the Challenged Claims. EX1005(McGorin),

Section VI.C. I have reviewed the McGorin Declaration and rely on Dr. McGorin’s opinions that the ’241 patent claims are not entitled to the January 11, 2013 priority date of the ’816 Provisional.

VI. CHALLENGED CLAIMS

57. I have analyzed claims 1-23 of the ’241 patent in connection with Motif’s Petition for *inter partes* review that accompanies this Declaration. I understand Motif is challenging the validity of claims 1-23 (“Challenged Claims”). The Challenged Claims are reproduced below for reference.

Claim 1	
Element No.	Claim Limitation
1[pre]	A meat-like-food product produced by a method comprising:
1[a]	providing one or more plant proteins; and
1[b]	combining, with the one or more plant proteins: a composition comprising a heme-containing protein, wherein the composition comprises at least 60% of the heme-containing protein on a dry weight basis;
1[c]	a compound selected from glucose, ribose, fructose, lactose, xylose, arabinose, glucose-6-phosphate, maltose, and galactose, and mixtures of two or more thereof; and
1[d]	a compound selected from cysteine, cystine, thiamine, methionine, and mixtures of two or more thereof in a concentration of at least 1.5 mM;
1[e]	wherein the meat-like food product is free of animal heme-containing protein;

1[f]	wherein cooking the meat-like-food-product results in the production of at least two volatile compounds which have a meat-associated aroma; and
1[g]	wherein the meat-like food product is in a form selected from the group consisting of a hotdog, a burger, ground meat, a sausage, a steak, a filet, a roast, a meatball, a meatloaf, or bacon.
Claim 2	
2. The meat-like-food product of claim 1, wherein the one or more plant proteins comprise a textured vegetable protein.	
Claim 3	
3. The meat-like-food product of claim 2, wherein the textured vegetable protein is textured soy protein.	
Claim 4	
4. The meat-like-food product of claim 1, wherein the composition comprising the heme-containing protein comprises at least 70% of the heme-containing protein on a dry weight basis.	
Claim 5	
5. The meat-like-food product of claim 1, wherein the composition comprising the heme-containing protein comprises at least 80% of the heme-containing protein on a dry weight basis.	
Claim 6	
6. The meat-like-food product of claim 1, wherein the heme-containing protein is a globin.	
Claim 7	
7. The meat-like-food product of claim 1, wherein the heme-containing protein comprises an amino acid sequence having at least 80% sequence identity to a polypeptide set forth in SEQ ID NOs. 1-26.	
Claim 8	

8. The meat-like-food product of claim 1, wherein the cysteine is added to a concentration of about 0.8 mM to about 10 mM.
Claim 9
9. The meat-like-food product of claim 1, wherein the thiamine is added to a concentration of about 0.1 mM to about 2 mM.
Claim 10
10. The meat-like-food product of claim 1, further comprising combining, with the one or more plant proteins, one or more of inosine, inosine monophosphate (IMP), guanosine, guanosine monophosphate (GMP), and adenosine monophosphate (AMP).
Claim 11
11. The meat-like-food product of claim 1, further comprising combining with the one more plant proteins, one or more of beta-carotene, alpha-tocopherol, caffeic acid, propyl gallate, and epigallocatechin gallate.
Claim 12
12. The meat-like-food product of claim 1, further comprising combining with the one more plant proteins, one or more of a vegetable oil, an algal oil, sunflower oil, corn oil, soybean oil, palm fruit oil, palm kernel oil, safflower oil, flaxseed oil, rice bran oil, cottonseed oil, olive oil, canola oil, flaxseed oil, coconut oil, and mango oil.
Claim 13
13. The meat-like-food product of claim 1, further comprising combining with the one more plant proteins, one or more of acetic acid, lactic acid, glycolic acid, citric acid, succinic acid, tartaric acid, caprylic acid, capric acid, lauric acid, myristic acid, palmitic acid, palmitoleic acid, stearic acid, oleic acid, linoleic acid, alpha linolenic acid, gamma linolenic acid, arachidic acid, arachidonic acid, behenic acid, and erucic acid.
Claim 14
14. The meat-like-food product of claim 1, wherein cooking comprises heating the meat-like food product at 150° C. for about 3 to about 5 minutes.

Claim 15

15. The meat-like-food product of claim 1, wherein the meat-like food product has a pink to red color before cooking to indicate a raw or uncooked state.

Claim 16

16. The meat-like-food product of claim 1, wherein at least a portion of the meat-like food product, upon cooking, transitions in color from a pink to red color in a raw or uncooked state to a lighter pink to brown color in a partially cooked to fully cooked state.

Claim 17

17. The meat-like-food product of claim 1, wherein cooking the meat-like-food product results in the production of at least five volatile compounds selected from the group consisting of (1-ethyl-1-propenyl)-benzene, (E)-2-decenal, (E)-2-heptenal, (E)-2-hexenal, (E)-2-nonenal, (E)-2-octen-1-ol, (E)-2-octenal, (E)-2-tridecen-1-ol, (E)-3-penten-2-one, (E)-4-octene, (E)-5-decene, (E,E)-3,5-octadien-2-one, (Z)-2-decenal, (Z)-2-heptenal, (Z)-3-decen-1-ol, acetate, [(methylsulfonyl)methyl]-benzene, 1-(ethylthio)-2-(methylthio)-buta-1,3-diene, 1-(methylthio)-propane, 1,1'-(1,2-cyclobutanediyl)bis-cis-benzene, 1,10-undecadiene, 1,3,5-cycloheptatriene, 1,3-bis(1,1-dimethylethyl)-benzene, 1,3-diisopropoxy-1,3-dimethyl-1,3-disilacyclobutane, 1,3-dimethyl-benzene, 1-decen-3-one, 1-heptanol, 1-heptyl-1,2,3,4-tetrahydro-4-methyl-naphthalene, 1-hexanol, 1-hydroxy-2-propanone, 1-nonanol, 1-octanol, 1-octen-3-ol, 1-octen-3-one, 1-octene, 1-pentanol, 1-penten-3-one, 1-undecanol, 2,2,4,6,6-pentamethyl-heptane, 2,3,4-trimethyl-pentane, 2,3-butanedione, 2,3-dihydro-5-methyl-furan, 2,3-dimethyl-pyrazine, 2,4-decadienal, 2,4-dimethyl-1-heptene, 2,5-dimethyl-pyrazine, 2-acetetyl-1-propene, 2-acetyl-propen-2-ol, 2-acetylthiazole, 2-butanone, 2-butenal, 2-butyl-1-decene, 2-decanone, 2-decenal, 2-ethyl-5-methyl-pyrazine, 2-ethylacrolein, 2-ethyl-furan, 2-heptanone, 2-heptenal, 2-hexyl furan, 2-methyl-1(H)-pyrrole, 2-methyl-1-heptene, 2-methyl-1-penten-1-one, 2-methyl-3-(methylthio) furan, 2-methyl-3-furanthiol, 2-methyl-5-(methylthio)-furan, 2-methyl-butanal, 2-methyl-cyclopentanone, 2-methyl-furan, 2-methyl-heptane, 2-methyl-pentanal, 2-methyl-propanal, 2-methyl-thiazole, 2-n-octylfuran, 2-nonanone, 2-nonen-4-one, 2-octanone, 2-octenal, 2-pentanone, 2-pentyl-furan, 2-pentyl-thiophene, 2-phenylpropenal, 2-propenal, 2-propenoic acid, methyl ester, 2-thiophenecarboxaldehyde, 2-tridecen-1-ol, 2-undecanone, 2-undecenal, 3-(methylthio)-propanenitrile, 3-(phenylmethyl)-2,5-piperazinedione, 3,3'-

dithiobis-2-methyl-furan, 3,5-bis(1,1-dimethylethyl)-phenol, 3,5-di-tert-butylbenzoic acid, 3-decen-2-one, 3-ethylcyclopentanone, 3-ethyl-pentane, 3-methyl-2-butenal, 3-methyl-2-thiophenecarboxaldehyde, 3-methyl-3-buten-2-one, 3-methyl-butanal, 3-methyl-furan, 3-methylheptyl acetate, 3-methyl-pentanal, 3-pentyl-furan, 3-phenyl-furan, 3-thiophenecarboxaldehyde, 3-thiophenemethanol, 4,7-dimethyl-undecane, 4-chloro-2,6-bis(1,1-dimethylethyl)-phenol, 4-ethoxy-benzoic acid, ethyl ester, 4-ethyl-2-methyl-pyrrole, 4-ethyl-benzaldehyde, 4-methyl-2-heptanone, 4-methyl-5-thiazoleethanol, 4-methylthiazole, 4-nitrophenyl 2-thiophenecarboxylic acid ester, 4-penten-2-one, 4-quinolinecarboxaldehyde, 5-(2-chloroethyl)-4-methylthiazole, 5-ethenyl-4-methyl-thiazole, 5-ethyl-dihydro-2(3H)-furanone, 5-formyl-4-methylthiazole, 5-methyl-1-undecene, 6-methyl-2-heptanone, 7-methyl-(E)-5-undecene, 9-octadecenal, acetaldehyde, acetic acid, acetone, acetonitrile, acetophenone, acetyl valeryl, aminophenylacetylene, benzaldehyde, benzene, benzoic acid, benzyl alcohol, bis(2-methyl-4,5-dihydro-3-furyl) disulfide, butanal, butanone, butyrolactone, carbon disulfide, decanal, dihydro-3-(2H)-thiophenone, dihydro-5-pentyl-2(3H)-furanone, dimethyl selenone, dimethyl sulfide, dimethyl trisulfide, dodecanal, ethanol, ethyl acetate, formic acid, heptyl ester, furan, furfural, heptanal, hexanoic acid, isopropyl alcohol, isothiazole, isothiocyanato-methane, m-aminophenylacetylene, methacrolein, methanethiol, methional, methyl (methylthio)methyl disulfide, methyl isopropyl disulphide, methyl thiolacetate, methyl vinyl ketone, methyl-pyrazine, methyl-thiirane, nonanal, octanal, octane, oxalic acid, diallyl ester, oxalic acid, isobutyl pentyl ester, p cresol, p-dithiane-2,5-diol, pentanal, pentanoic acid, 2,2,4-trimethyl-3-hydroxy-, isobutyl ester, phenol, phenylacetaldehyde, propanal, propyl-cyclopropane, p-xylene, pyrazine, pyrrole, styrene, thiazole, thiocyanic acid, methyl ester, thiophene, toluene, trans-2-(2-pentenyl)furan, and tridecane.

Claim 18

18. The meat-like food product of claim 1, wherein cooking the meat-like food product results in the production of at least ten volatile compounds selected from the group consisting of (1-ethyl-1-propenyl)-benzene, (E)-2-decenal, (E)-2-heptenal, (E)-2-hexenal, (E)-2-nonenal, (E)-2-octen-1-ol, (E)-2-octenal, (E)-2-tridecen-1-ol, (E)-3-penten-2-one, (E)-4-octene, (E)-5-decene, (E,E)-3,5-octadien-2-one, (Z)-2-decenal, (Z)-2-heptenal, (Z)-3-decen-1-ol, acetate, [(methylsulfonyl)methyl]-benzene, 1-(ethylthio)-2-(methylthio)-buta-1,3-diene, 1-(methylthio)-propane, 1,1'-(1,2-cyclobutanediyl)bis-cis-benzene, 1,10-undecadiene, 1,3,5-cycloheptatriene, 1,3-bis(1,1-dimethylethyl)-benzene, 1,3-diisopropoxy-1,3-dimethyl-1,3-disilacyclobutane, 1,3-dimethyl-benzene, 1-

decen-3-one, 1-heptanol, 1-heptyl-1,2,3,4-tetrahydro-4-methyl-naphthalene, 1-hexanol, 1-hydroxy-2-propanone, 1-nonanol, 1-octanol, 1-octen-3-ol, 1-octen-3-one, 1-octene, 1-pentanol, 1-penten-3-one, 1-undecanol, 2,2,4,6,6-pentamethylheptane, 2,3,4-trimethyl-pentane, 2,3-butanedione, 2,3-dihydro-5-methyl-furan, 2,3-dimethyl-pyrazine, 2,4-decadienal, 2,4-dimethyl-1-heptene, 2,5-dimethylpyrazine, 2-acetetyl-1-propene, 2-acetyl-propen-2-ol, 2-acetylthiazole, 2-butanone, 2-butenal, 2-butyl-1-decene, 2-decanone, 2-decenal, 2-ethyl-5-methylpyrazine, 2-ethylacrolein, 2-ethyl-furan, 2-heptanone, 2-heptenal, 2-hexyl furan, 2-methyl-1(H)-pyrrole, 2-methyl-1-heptene, 2-methyl-1-penten-1-one, 2-methyl-3-(methylthio) furan, 2-methyl-3-furanthiol, 2-methyl-5-(methylthio)-furan, 2-methyl-butanal, 2-methyl-cyclopentanone, 2-methyl-furan, 2-methyl-heptane, 2-methyl-pentanal, 2-methyl-propanal, 2-methyl-thiazole, 2-n-octylfuran, 2-nonanone, 2-nonen-4-one, 2-octanone, 2-octenal, 2-pentanone, 2-pentyl-furan, 2-pentyl-thiophene, 2-phenylpropenal, 2-propenal, 2-propenoic acid, methyl ester, 2-thiophenecarboxaldehyde, 2-tridecen-1-ol, 2-undecanone, 2-undecenal, 3-(methylthio)-propanenitrile, 3-(phenylmethyl)-2,5-piperazinedione, 3,3'-dithiobis-2-methyl-furan, 3,5-bis(1,1-dimethylethyl)-phenol, 3,5-di-tert-butylbenzoic acid, 3-decen-2-one, 3-ethylcyclopentanone, 3-ethyl-pentane, 3-methyl-2-butenal, 3-methyl-2-thiophenecarboxaldehyde, 3-methyl-3-buten-2-one, 3-methyl-butanal, 3-methyl-furan, 3-methylheptyl acetate, 3-methylpentanal, 3-pentyl-furan, 3-phenyl-furan, 3-thiophenecarboxaldehyde, 3-thiophenemethanol, 4,7-dimethyl-undecane, 4-chloro-2,6-bis(1,1-dimethylethyl)-phenol, 4-ethoxy-benzoic acid, ethyl ester, 4-ethyl-2-methyl-pyrrole, 4-ethyl-benzaldehyde, 4-methyl-2-heptanone, 4-methyl-5-thiazoleethanol, 4-methylthiazole, 4-nitrophenyl 2-thiophenecarboxylic acid ester, 4-penten-2-one, 4-quinolinecarboxaldehyde, 5-(2-chloroethyl)-4-methylthiazole, 5-ethenyl-4-methyl-thiazole, 5-ethyldihydro-2(3H)-furanone, 5-formyl-4-methylthiazole, 5-methyl-1-undecene, 6-methyl-2-heptanone, 7-methyl-(E)-5-undecene, 9-octadecenal, acetaldehyde, acetic acid, acetone, acetonitrile, acetophenone, acetyl valeryl, aminophenylacetylene, benzaldehyde, benzene, benzoic acid, benzyl alcohol, bis(2-methyl-4,5-dihydro-3-furyl) disulfide, butanal, butanone, butyrolactone, carbon disulfide, decanal, dihydro-3-(2H)-thiophenone, dihydro-5-pentyl-2(3H)-furanone, dimethyl selenone, dimethyl sulfide, dimethyl trisulfide, dodecanal, ethanol, ethyl acetate, formic acid, heptyl ester, furan, furfural, heptanal, hexanoic acid, isopropyl alcohol, isothiazole, isothiocyanato-methane, m-aminophenylacetylene, methacrolein, methanethiol, methional, methyl (methylthio)methyl disulfide, methyl isopropyl disulphide, methyl thiolacetate, methyl vinyl ketone, methyl-pyrazine, methyl-thiirane, nonanal, octanal, octane, oxalic acid, diallyl ester, oxalic acid, isobutyl pentyl ester, p cresol, p-dithiane-2,5-diol, pentanal, pentanoic acid, 2,2,4-trimethyl-3-hydroxy-, isobutyl ester, phenol,

phenylacetaldehyde, propanal, propyl-cyclopropane, p-xylene, pyrazine, pyrrole, styrene, thiazole, thiocyanic acid, methyl ester, thiophene, toluene, trans-2-(2-pentenyl)furan, and tridecane.

Claim 19

19. The meat-like-food product of claim 1, wherein cooking the meat-like-food product results in the production of at least twenty volatile compounds selected from the group consisting of (1-ethyl-1-propenyl)-benzene, (E)-2-decenal, (E)-2-heptenal, (E)-2-hexenal, (E)-2-nonenal, (E)-2-octen-1-ol, (E)-2-octenal, (E)-2-tridecen-1-ol, (E)-3-penten-2-one, (E)-4-octene, (E)-5-decene, (E,E)-3,5-octadien-2-one, (Z)-2-decenal, (Z)-2-heptenal, (Z)-3-decen-1-ol, acetate, [(methylsulfonyl)methyl]-benzene, 1-(ethylthio)-2-(methylthio)-buta-1,3-diene, 1-(methylthio)-propane, 1,1'-(1,2-cyclobutanediyl)bis-cis-benzene, 1,10-undecadiene, 1,3,5-cycloheptatriene, 1,3-bis(1,1-dimethylethyl)-benzene, 1,3-diisopropoxy-1,3-dimethyl-1,3-disilacyclobutane, 1,3-dimethyl-benzene, 1-decen-3-one, 1-heptanol, 1-heptyl-1,2,3,4-tetrahydro-4-methyl-naphthalene, 1-hexanol, 1-hydroxy-2-propanone, 1-nonanol, 1-octanol, 1-octen-3-ol, 1-octen-3-one, 1-octene, 1-pentanol, 1-penten-3-one, 1-undecanol, 2,2,4,6,6-pentamethyl-heptane, 2,3,4-trimethyl-pentane, 2,3-butanedione, 2,3-dihydro-5-methyl-furan, 2,3-dimethyl-pyrazine, 2,4-decadienal, 2,4-dimethyl-1-heptene, 2,5-dimethyl-pyrazine, 2-acetetyl-1-propene, 2-acetyl-propen-2-ol, 2-acetylthiazole, 2-butanone, 2-butenal, 2-butyl-1-decene, 2-decanone, 2-decenal, 2-ethyl-5-methyl-pyrazine, 2-ethylacrolein, 2-ethyl-furan, 2-heptanone, 2-heptenal, 2-hexyl furan, 2-methyl-1(H)-pyrrole, 2-methyl-1-heptene, 2-methyl-1-penten-1-one, 2-methyl-3-(methylthio) furan, 2-methyl-3-furanthiol, 2-methyl-5-(methylthio)-furan, 2-methyl-butanal, 2-methyl-cyclopentanone, 2-methyl-furan, 2-methyl-heptane, 2-methyl-pentanal, 2-methyl-propanal, 2-methyl-thiazole, 2-n-octylfuran, 2-nonanone, 2-nonen-4-one, 2-octanone, 2-octenal, 2-pentanone, 2-pentyl-furan, 2-pentyl-thiophene, 2-phenylpropenal, 2-propenal, 2-propenoic acid, methyl ester, 2-thiophenecarboxaldehyde, 2-tridecen-1-ol, 2-undecanone, 2-undecenal, 3-(methylthio)-propanenitrile, 3-(phenylmethyl)-2,5-piperazinedione, 3,3'-dithiobis-2-methyl-furan, 3,5-bis(1,1-dimethylethyl)-phenol, 3,5-di-tert-butylbenzoic acid, 3-decen-2-one, 3-ethylcyclopentanone, 3-ethyl-pentane, 3-methyl-2-butenal, 3-methyl-2-thiophenecarboxaldehyde, 3-methyl-3-buten-2-one, 3-methyl-butanal, 3-methyl-furan, 3-methylheptyl acetate, 3-methyl-pentanal, 3-pentyl-furan, 3-phenyl-furan, 3-thiophenecarboxaldehyde, 3-thiophenemethanol, 4,7-dimethyl-undecane, 4-chloro-2,6-bis(1,1-dimethylethyl)-phenol, 4-ethoxy-benzoic acid, ethyl ester, 4-ethyl-2-methyl-pyrrole, 4-ethyl-benzaldehyde, 4-methyl-2-heptanone, 4-methyl-5-thiazoleethanol, 4-

methylthiazole, 4-nitrophenyl 2-thiophenecarboxylic acid ester, 4-penten-2-one, 4-quinolinecarboxaldehyde, 5-(2-chloroethyl)-4-methylthiazole, 5-ethenyl-4-methyl-thiazole, 5-ethyldihydro-2(3H)-furanone, 5-formyl-4-methylthiazole, 5-methyl-1-undecene, 6-methyl-2-heptanone, 7-methyl-(E)-5-undecene, 9-octadecenal, acetaldehyde, acetic acid, acetone, acetonitrile, acetophenone, acetyl valeryl, aminophenylacetylene, benzaldehyde, benzene, benzoic acid, benzyl alcohol, bis(2-methyl-4,5-dihydro-3-furyl) disulfide, butanal, butanone, butyrolactone, carbon disulfide, decanal, dihydro-3-(2H)-thiophenone, dihydro-5-pentyl-2(3H)-furanone, dimethyl selenone, dimethyl sulfide, dimethyl trisulfide, dodecanal, ethanol, ethyl acetate, formic acid, heptyl ester, furan, furfural, heptanal, hexanoic acid, isopropyl alcohol, isothiazole, isothiocyanato-methane, m-aminophenylacetylene, methacrolein, methanethiol, methional, methyl (methylthio)methyl disulfide, methyl isopropyl disulphide, methyl thiolacetate, methyl vinyl ketone, methyl-pyrazine, methyl-thiirane, nonanal, octanal, octane, oxalic acid, diallyl ester, oxalic acid, isobutyl pentyl ester, p cresol, p-dithiane-2,5-diol, pentanal, pentanoic acid, 2,2,4-trimethyl-3-hydroxy-, isobutyl ester, phenol, phenylacetaldehyde, propanal, propyl-cyclopropane, p-xylene, pyrazine, pyrrole, styrene, thiazole, thiocyanic acid, methyl ester, thiophene, toluene, trans-2-(2-pentenyl)furan, and tridecane.	
Claim 20	
20. The meat-like-food product of claim 1, wherein the at least two volatile compounds are selected from 2-methyl-furan, bis(2-methyl-3-furyl)disulfide, 2-pentyl-furan, 3,3'-dithiobis-2-methyl-furan, 2,5-dimethyl-pyrazine, 2-methyl-3-furanthiol, dihydro-3-(2H)-thiophenone, 5-methyl-2-thiophenecarboxaldehyde, 3-methyl-2-thiophenecarboxaldehyde, 2-methyl-thiazole, dimethyl sulfide, decanal, 5-ethyldihydro-2(3H)-furanone, dihydro-5-pentyl-2(3H)-furanone, 2-octanone, 3,5-octadien-2-one, p Cresol, p cresol, and hexanoic acid.	
Claim 21	
20. The meat-like-food product of claim 1, wherein the at least two volatile compounds are 2-methyl-furan and bis(2-methyl-3-furyl)disulfide.	
Claim 22	
22[pre]	A meat-like-food product produced by a method comprising:
22[a]	providing one or more plant proteins; and

22[b]	combining, with the one or more plant proteins: a heme-containing protein;
22[c]	one or more of glucose, ribose, fructose, lactose, xylose, arabinose, glucose-6-phosphate, maltose, and galactose; and
22[d]	one or more of cysteine, cystine, thiamine, and methionine;
22[e]	wherein the meat-like food product is free of animal heme-containing protein;
22[f]	wherein cooking the meat-like-food-product results in the production of at least two volatile compounds which have a meat-associated aroma; and
22[g]	wherein the meat-like food product is in a form selected from the group consisting of a hotdog, a burger, ground meat, a sausage, a steak, a filet, a roast, a meatball, a meatloaf, or bacon.
Claim 23	
23. The meat-like food product of claim 22, wherein the meat-like food product is free of animal products.	

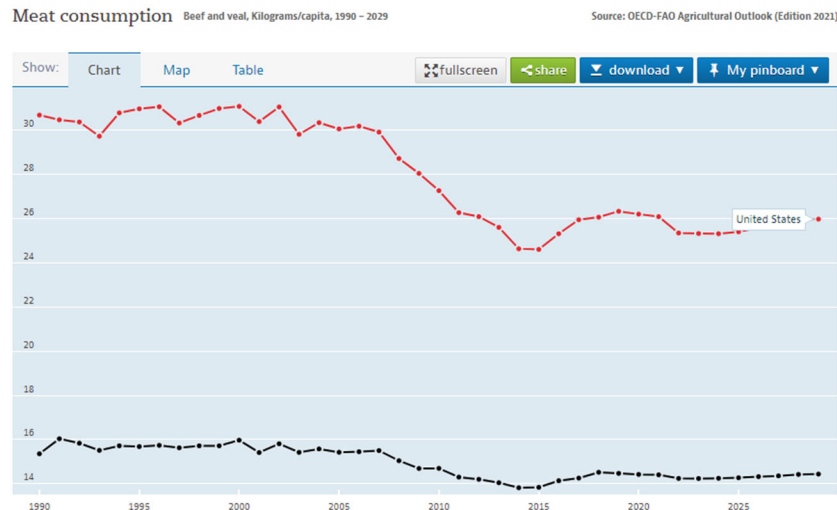
VII. STATE OF THE ART

A. Benefits of Artificial Meat Flavor Additives and Meat Substitutes

1. Meat Consumption

58. 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.

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



EX1123(OECD). 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.

60. 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 Benefits

61. 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 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.

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.

3. Environmental Benefits

62. 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.

63. 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

64. 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.

65. 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.

66. 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

67. 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.

68. 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.

1. Nutritional Content of Meat

69. 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.

70. 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.

71. 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

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

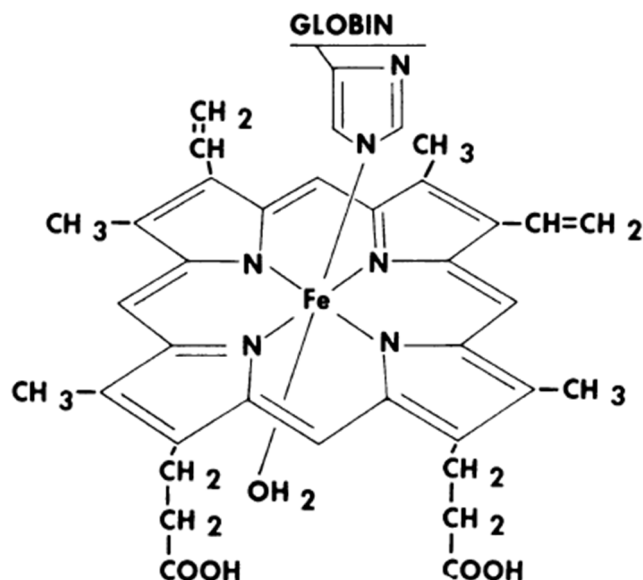
Although hemoglobin is the predominant pigment in the living animal, after slaughter by bleeding, myoglobin becomes the major pigment. Myoglobin accounts for only 10% of the total iron in the live animal, but after bleeding, may account for as much as 95% of the iron in beef skeletal muscle. Nevertheless, 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.

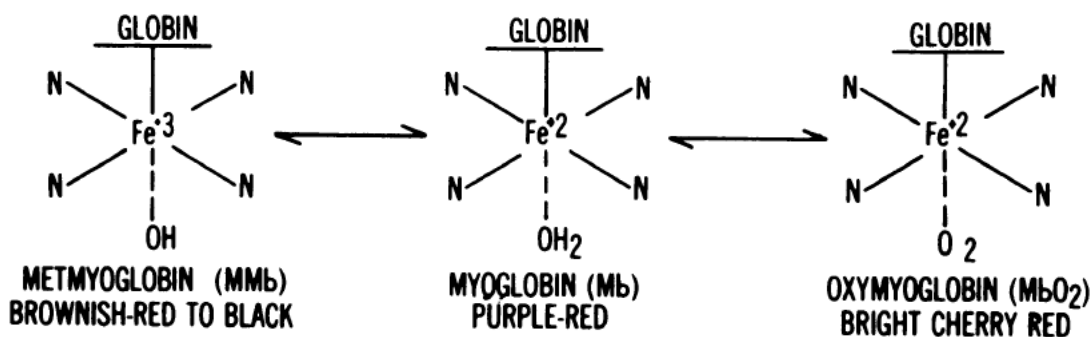
EX1027(Pearson), 66.

73. 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.

74. 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.

75. 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.”).

76. 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

77. Like hemoglobin and myoglobin found in animals, plant hemoglobins 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), 78-79.

78. 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.*, 1521.

79. Based on their extensive 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.” *Id.*, 1522. Thus, soy root nodule can be a “novel value-added product for soy producers.” *Id.*, 1522.

C. Recombinant Technology

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

81. 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.” *Id.*, 282, 285 (As “the seeds from the transgenic rice accumulated up to threefold more iron...than normal seeds...[t]his 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.

82. 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).

D. Meat Flavor Chemistry

83. 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.

84. 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(McGorin). 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.

VIII. SUMMARY OF THE PRIOR ART

A. “Brown” – EX1012

85. I have reviewed International Patent Application No. WO 2013/010042 to Brown et al. (“Brown”). Brown was filed on July 12, 2012 and

claims priority to a U.S. provisional application dated July 12, 2011. Brown was published on January 17, 2013. Brown only shares a single inventor listed on the '241 patent, and thus I have been informed was invented by "another." Hence, I understand that Brown is considered prior art under pre-AIA 35 U.S.C. § 102(e), or, in the alternative under AIA 35 U.S.C. § 102(a)(2).

86. I understand that Brown is also prior art under 35 U.S.C. § 102(a)(1) because the '241 patent is not entitled to the '816 Provisional's January 11, 2013 priority date. *See supra*, Section V.E.

87. Brown is generally directed to a "meat substitute composition" that "accurately mimics the taste, texture, or color of a meat product derived from animal sources." EX1012(Brown), [0006]. The meat substitute "may be made entirely from plant based sources." *Id.*, [00273], [00296]. Notably, Brown discloses that the meat substitute includes a heme-containing protein, *e.g.*, soy leghemoglobin, that "contributes favorably to aroma of meat replicas." *Id.*, [00364].

88. Brown discloses one exemplary formula for a "muscle replica" that together with fat and connective tissue replicas, forms a "meat replica." *See, e.g.*, EX1012(Brown), [00364] (muscle replica formula), [00189] (describing "a meat substitute product" having "a muscle replica; a fat tissue replica; and a connective tissue replica" that "assembled in a manner that approximates the physical organization of meat"), [00191] (exemplary percentages of muscle, fat, and

connective tissue replicas), [00305]-[00311] (muscle replicas), [00312]-[00322] (fat replicas), [00323]-[00359] (connective tissue replicas). The muscle replica comprises “pea flour, sunflower oil, and glucose” and is “heated for 10 minutes at 140C in the presence of... leghemoglobin (LHb)” to provide volatile compounds that “are often associated with the aroma of cooked meat.” *Id.*, [00364].

89. Generally, Brown also teaches that “flavor and fragrance components...produced during the cooking process by chemical reactions including amino acids, fats and sugars, which are found in plants as well as meat,” can be used to produce a meaty aroma and flavor. *Id.*, [00295]. Mixtures of these components “enable these compounds to undergo chemical reactions during cooking to produce odorants and flavor-producing compounds.” *Id.*, [00361]. “Odorants released during cooking of meat are generated by reactions that can involve as reactants fats, protein, amino acids, peptides, nucleotides, organic acids, sulfur compounds, sugars, and other carbohydrates.” *Id.*, [00362].

90. Brown also explains that “[s]ome reactions that generate odorants released during cooking of meat can be catalyzed by iron, in particular the heme iron of myoglobin.” *Id.* [00363]. Thus, Brown states that “some of the characteristic flavor and fragrance components are produced during the cooking process by chemical reactions catalyzed by heme.” *Id.* In some embodiments, “the meat replica . . . comprises an iron-carrying protein” that “has been isolated and purified from a

source” by various percentages. *Id.* [00367]. Indeed, Brown teaches methods for isolating leghemoglobin for use in its muscle replicas. *See, e.g., id.*, [00376]-[00380], [0089]-[0090].

B. “Rovaart” – EX1125

91. I have also reviewed U.S. Patent No. 3,930,044 (“Rovaart”) issued on December 30, 1975. I understand that Rovaart is prior art under §102(a)(1)/pre-AIA §102(b). 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(Rovaart), Abstract.

C. “Ronai” – EX1132

92. I have also reviewed U.S. Patent No. 4,153,738 (“Ronai”) issued on May 8, 1979. I understand that Ronai is prior art under §102(a)(1)/pre-AIA §102(b). Ronai teaches a “dried flaked textured high vegetable protein material which instantly hydrates and has an improved flavor.” EX1132(Ronai), 1:37-39. Specifically, Ronai teaches “the conversion of soybeans to texturized flakes.” *Id.*, 3:23-25. Ronai teaches that its textured soy protein flakes “can be used in an endless variety of ways to furnish vegetable protein as a meat protein substitute,” such as “to produce products which simulate fish, poultry ..., beef, veal, liver, mutton and ham.” *Id.*, 8:55-68.

D. “MacLeod” – EX1024

93. I have also reviewed “*Natural and Simulated Meat Flavors (With Particular Reference to Beef)*,” by Glesni MacLeod and M. Seyyedain-Ardebili (“MacLeod”), published in Volume 14, Issue 4 of the journal *Critical Reviews in Food Science and Nutrition* on August 1981.

94. As a person of ordinary skill in the art, I am familiar with the journal *Critical Reviews in Food Science and Nutrition*, as well as its publisher, the Taylor & Francis Group. The journal was actually published by the CRC Press in 1981, which was acquired in the early 2000s by Taylor & Francis. CRC Press was founded in 1903 and by 1981 was a reputable publisher of several journals in the chemistry arts. By the time of its acquisition, Taylor & Francis was (and still is) a leading source of scientific information within the field of food science and publishes thousands of peer-reviewed scientific journals every year—indeed, it is known as one of the “Big Four” STEM publishers.

95. In particular, the journal *Critical Reviews in Food Science and Nutrition* has, for decades, been a highly-reputable scientific journal within the field of food science. By 1981, and certainly by 2011, POSITA would have considered the publication dates provided on Taylor & Francis’s website, the face of the journal, and the face of the paper itself to all be reliable indicators of its publication

date. Thus, it is my opinion that MacLeod was available to a POSITA exercising reasonable diligence by 1981, and certainly by 2011.

96. MacLeod was published more than three decades before the '241 patent's earliest alleged priority date. MacLeod describes in detail the science behind meat flavors and aroma including the various chemical reactions that select compounds can undergo to produce volatile compounds that are associated with a meaty aroma. MacLeod also describes the state of the art (as of 1981), providing a comprehensive overview of research and patents that describe the preparation of simulated meat flavoring compositions.

E. “Giacino” – EX1015

97. I have also reviewed U.S. Patent No. 3,519,437 (“Giacino”), titled “Meat Flavor Compositions.” Giacino issued on July 7, 1970, more than four decades before the '241 patent. Giacino discloses “artificial meaty flavoring compositions and [] processes for preparing them.” EX1015(Giacino), 1:19-20. The compositions have “meaty flavor characteristics such as beef, pork, and poultry flavor” and can be used for “novel food compositions containing them.” *Id.*, 1:21-25. Giacino acknowledges the ubiquity of cysteine in prior art meat flavoring compositions: “[I]t has been regarded as being highly desirable if not essential, to include cysteine in food flavor compositions.” *Id.*, 4:47-49. Giacino also discloses that “the compositions of the invention are amenable to the inclusion of cysteine as

seen fit by the individual processors.” *Id.*, 4:49-53. Indeed, many of Giacino’s exemplary meat flavoring compositions include cysteine and thiamine. *See, e.g., id.*, 4:63-5:20, 7:40-58 (L-cysteine hydrochloride, thiamine hydrochloride), 8:37-60 (same).

F. “Conrad” - EX1013

98. 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 ’241 patent.

99. 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.

G. “Crane” – EX1014

100. I have also reviewed U.S. Patent Application Publication 2011/0287467 by Crane and Sudhamsu (“Crane”). U.S. Patent Application No. 13/113,769 was filed on May 23, 2011, published on November 24, 2011, and claims

priority from U.S. Provisional Application No. 61/347,193 filed on May 21, 2010.

Hence, Crane is prior art under pre-AIA 102(b) (or alternatively under AIA 35 U.S.C. § 102(a)(1)) because it was published more than a year before the '241 patent's effective filing date.

101. Crane teaches “methods of producing recombinant functional heme-binding proteins with complete heme incorporation and purified preparations” thereof. EX1014(Crane), 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(Crane), [0024].

H. “Proulx” – EX1019

102. 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”).

103. As 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 Proulx was available to a POSITA exercising reasonable diligence by 2006.

104. I understand that Proulx is considered prior art under AIA 35 U.S.C. § 102(a)(1) or, in the alternative, under 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 '241 patent.

105. The Proulx article generally relates to the use of plant-derived soy leghemoglobin to fortify non-animal food products. *See* EX1019(Proulx), 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.

106. 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).” *Id.*, 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.

I. “Rolan” – EX1021

107. I have reviewed U.S. Patent Application Publication No. 2008/0268112 to Rolan et al. (“Rolan”), published on October 30, 2008. I understand that Rolan is considered prior art under AIA 35 U.S.C. § 102(a)(1) or, in the alternative, under 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 ’241 patent.

108. Rolan generally relates to “meat compositions and meat analog compositions having improved nutritional properties.” EX1021(Rolan), [0002]. For example, Rolan teaches “ground meat compositions” comprising “structured protein

product” with “protein fibers that are substantially aligned,” “meat”; and “an optional color composition having coloring agents,” such as “a reducing sugar.” *Id.*, [0005]. The ground meat compositions “have improved nutritional properties, such as reduced fat and cholesterol, without sacrificing flavor, texture, mouth feel, and aroma of ground meat.” *Id.*, [0017].

109. Rolan’s structured protein product is a meatless composition that includes, among other things, soy protein isolate, wheat gluten, wheat starch, and cysteine. *Id.*, [0157]. Rolan discloses that a “flavoring agent” may also be added that “may mimic or replace constituents found in lean meat or fat tissues, such as...muscle proteins.” *Id.*, [0077], [0096]. Rolan’s composition may be fortified by vitamins, minerals, and other nutrients “to create a product with a nutrient composition comparable to animal meat products.” *Id.*, [0100]. Additionally, a thermally unstable pigment may also be added to the structured protein product to give it a reddish color that resembles raw meat when uncooked, but that turns brown once cooked. *See id.*, [0081]-[0083].

IX. SUMMARY OF OPINIONS

110. In my opinion, claims 1-23 are unpatentable based on the following grounds:

No.	Claims	Ground for Challenge
1A	1-9, 12-23	§103: Brown, Giacino
1B	2-3	§103: Brown, Giacino, Ronai
1C	10-11	§103: Brown, Giacino, Rolan
2A	1, 4-6, 8, 10, 13, 15-23	§103: Rovaart, Conrad, Crane
2B	2-3	§103: Rovaart, Conrad, Crane, Ronai
2C	8-9, 14	§103: Rovaart, Conrad, Crane, Giacino
2D	11-12	§103: Rovaart, Conrad, Crane, Rolan
3A	1, 4-8, 10, 13-23	§103: Rovaart, Conrad, Proulx
3B	2-3	§103: Rovaart, Conrad, Proulx, Ronai
3C	8-9, 14	§103: Rovaart, Conrad, Proulx, Giacino
3D	11-12	§103: Rovaart, Conrad, Proulx, Rolan

X. CLAIM CONSTRUCTION

111. I have been asked to review the '241 patent claims to determine how a POSITA would interpret the claims at the time of the invention in view of the patent and file history.

A. **“wherein the meat-like food product is free of animal heme-containing protein”**

112. Claims 1 and 22 recite “wherein the meat-like food product is free of animal heme-containing protein.” In my opinion, this limitation should be given its plain and ordinary meaning and need not be construed.

113. However, I understand that Patent Owner has taken the position that the term “free of animal heme-containing protein” should be interpreted to include proteins that are native to an animal species, *i.e. Bos taurus* (the domesticated bovine) but are not obtained from a previously live animal.

114. I have reviewed Patent Owner’s Second Amended Complaint (“SAC”) which I understand to have been filed in the co-pending Litigation. 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 22 of the ’241 patent. EX1116(SAC), ¶32. I am further informed and understand that a claim term such as “free of 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).

115. Thus, based on Patent Owner’s interpretation, Grounds 2A-2D below (*see infra*, Section XII) map “heme-containing protein” to bovine hemoglobin

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 2A-2D are unaffected because they also alternatively map "heme-containing protein" to leghemoglobin, which is a heme-containing protein native to plants.

B. The process limitations lack patentable weight

116. Claims 1 and 22 (and their dependent claims) recite "[a] meat-like-food product produced by a method comprising" various steps. In my opinion, these claims recite product-by-process claims, as they claim a product that is produced by following the steps of a process.

117. I understand that the scope of product-by-process claims in determining patentability is based on the product itself, not the process for creating the product. I further understand that a claimed product-by-process is not patentable over a prior art product unless the process imparts a structural or functional difference to the product over the prior art product.

118. The process in claims 1 and 22 involve combining several compositions and compounds with a plant protein. I note in particular that the process in claims 1, 4, and 5 requires combining the plant protein with "a composition comprising a heme-containing protein, wherein the composition comprises at least 60% of the heme-containing protein on a dry weight basis" (claims 4 and 5 require 70 and 80%, respectively), *i.e.* a composition where the heme-containing protein is 60/70/80% of

the dry weight of the composition. In other words, the pea protein is combined with an ingredient containing a high percentage of heme-containing protein.

119. Similarly, the process in claim 1 requires combining the plant protein with “a compound selected from cysteine, cystine, thiamine, methionine, and mixtures of two or more thereof in a concentration of at least 1.5 mM.” Claim 8 requires the compound to contain cysteine at a concentration of 0.8 to 10 mM and claim 9 requires the compound to contain thiamine at a concentration of 0.1 to 2 mM. These claimed steps require that the plant protein is combined with an ingredient containing a certain concentration of cysteine, thiamine or other sulfur-containing precursor.

120. When looking at claims 1 and 22, the expressly claimed product is simply a “meat-like food product” that is “free of animal heme-containing protein,” that “when cook[ed,] results in the production of at least two volatile compounds which have a meat-associated aroma,” and that “is in a form” that resembles a meat product, such as a hotdog or ground meat. The remaining limitations of the claims simply describe the process for creating the claimed product. In my opinion, these process limitations do not necessarily impart a structural or functional difference to the claimed product over the prior art.

121. I note that the patent specification only generically discloses that different flavor/aroma profiles may result from combining heme-containing protein

with flavor precursors (e.g., sugars and sulfur-containing compounds) by “modulating” factors such as the type and amount of the heme-containing protein and flavor precursors, pH, water, cooking time and temperature. *See, e.g.*, EX1001, 12:59-13:6. But since the claimed process does not place any requirements on the amount of the compositions/compounds, the process could result in a product that has a minuscule amount of heme-protein, sugar, and sulfur compound such that they impart no structural or functional difference. This could occur especially if the ingredients are heated and extruded (which could burn off whatever minuscule amount of precursors were used), a step that is typically required to shape meat-like products into meat-like forms (e.g. ground meat, patties, hotdogs), as is claimed by the patent.

122. In my opinion, the limitations in claims 1, 4-5 and 8-9 that refer to the percentage by dry weight of the heme-containing protein or the concentration of the sulfur-containing precursors in particular do not impart any structural or functional difference to the product made by the process as compared to the prior art. The limitations do not recite any particular amount or proportion *between* the process ingredients—*e.g.* the limitations do not recite how much sugar should be combined relative to how much sulfur-containing precursor or heme protein. A POSITA would therefore understand the percentage/concentration limitations have no effect on the amount of the ingredient in the final product and thus may not affect the structure or

function of the product. Indeed, the concentrations of the ingredients in the final meat-like-food product would necessarily be different than the concentrations in the compositions/compounds of the process limitations before they are combined.

123. For example, mixing a compound comprising cysteine with a concentration of at least 1.5 mM with the other recited components (and any other components, since claim 1 is a “comprising” claim) could result in an undetectable or minuscule amount of cysteine, or it could result in the majority of the product being composed of cysteine—it depends entirely on how much of the cysteine compound was added to the mixture relative to the other ingredients.

124. To the extent Patent Owner argues that the sulfur precursor concentration limitations (e.g. “concentration of at least 1.5 mM”) refer to the concentration of the sulfur-containing precursors within the final meat-like-food product, that construction is not supported by the plain language of the claims or the specification. The plain language of claim 1 recites a meat-like-food product produced by a method where one of the steps involves “combining, with the ... plant proteins” a composition and two compounds, one of which is “a compound selected from cysteine, cystine, thiamine, methionine, and mixtures of two or more thereof in a concentration of at least 1.5 mM.” The plain language is that the concentration limitation modifies the *compound*.

125. In my opinion, there is no plausible reading of the claim wherein the limitation “in a concentration of at least 1.5 mM” modifies the “meat-like-food product.” As an initial matter, “mM” is the abbreviation of the SI unit millimolar, *i.e.* millimoles per liter, which a POSITA would understand refers the molar concentration of a **solution**. A “compound” containing a sulfur precursor typically is a solution, since the sulfur-containing precursors are solutes and can be dissolved in a solvent, typically water. By contrast, a meat-like-food product is **not** a solution, especially since it is claimed to take the form of various meat products such as ground meat. Thus, the plain meaning of the claims is that “1.5 mM” refers to the molar concentration of the precursor compound in the form of a solution.

126. The limitation “in a concentration of at least 1.5 mM” cannot modify the “meat-like-food product” also because the grammar of the claim does not support such a reading. The claim recites “a meat-like-food product produced by a method comprising ... [the step of] combining, with the one or more plant proteins, ... a [sulfur precursor] compound ... in a concentration of at least 1.5 mM.” There is no grammatical reading where “concentration of at least 1.5 mM” modifies the “meat-like-food product” since the limitation simply says the food product is produced by a method where various ingredients are combined. Indeed, the applicant knew how to add limitations to the meat-like-food product through the use of several “wherein the meat-like food product” clauses. At best, the limitation “concentration of at least

1.5 mM” could be read as modifying the step of combining a plant protein and a sulfur precursor compound. But that still does not set any limit on the amount of the sulfur precursor in the final meat-like-food product in view of the fact that there are no proportions for the other compounds / compositions or the plant proteins and claim 1 is a “comprising” claim wherein additional, unrecited ingredients could be added to the process, such as the addition of oils in claim 12.

127. Claim 8 recites “wherein *the* cysteine is added to a concentration of about 0.8 mM to about 10 mM.” Claim 9 similarly recites “wherein *the* thiamine is added to a concentration of about 0.1 mM to about 2 mM.” In these claims, a POSITA would understand that “the cysteine” and “the thiamine” have an antecedent basis in the sulfur-containing precursors listed for one of the compounds in claim 1. A POSITA would further understand that these limitations refer to adding the claimed sulfur compound to obtain a specific concentration within one compound before being combined with others in the claim.

128. The specification further supports such readings. For example, the specification describes “[a] replica burger with a precursor mixture of 10 mM glucose, 10 mM ribose, 10 mM cysteine, 1 mM thiamine, 1 mM glutamic acid, 1 mM GMP, and LegH.” EX1001, 22:24-27. Table 7, described as a list of “precursor mixes,” also lists several different combinations of the claimed sulfur-containing precursors measured in millimolars. *Id.*, 14-15. A POSITA would understand that

a “precursor mixture” refers to a mixture that prepared in advance and then added to a food product to provide it with flavor. A POSITA would therefore understand that the specification is referring to the concentrations of the sulfur-containing precursors within the *precursor mixture* and not the entire replica burger.

129. Notably, these “precursor mixes” were added to “[r]eplica burgers containing the ingredients in Table 4,” which lists several ingredients (none of them are the claimed sulfur-containing precursors) measured as “% precooked w/w.” EX1001, 20:8-9, 22:14. In other words, the patentee knew how to describe the concentration of ingredients in the final product by using weight.

130. Thus, in view of the plain language of the claims and the specification, the concentration limitation of the sulfur-containing precursors does not refer to the concentration in the entire meat-like-food product but rather the compound that, in one of the steps of the method, is combined with the plant protein.

131. Thus, at the very least, the dry weight percentage of the heme-protein and the concentration of the sulfur-containing precursor are limitations that do not impart any functional or structural difference in the claimed product over the prior art.

132. Now, another reason why it is my opinion that the process limitations do not impart structural or functional differences in the claimed meat-like-food product is because during prosecution of the ’241 patent, it was in fact the applicant’s

amendment to require the final meat-like-food product to be “free of animal heme-containing protein” that allowed the claims over the prior art that otherwise contained the claimed heme proteins, sugars and sulfur compounds. Thus, that limitation expressly imparts what the examiner believed was novel, non-obvious structure on the meat-like-food product. (But, as explained below, the benefits of non-animal heme-containing proteins for imparting meat-like flavor and aroma in food products was known for decades.)

C. **“a compound”**

133. The independent claims of the '241 patent recite several “compounds,” specifically “a compound selected from [sugars like glucose]” and “a compound selected from [sulfur-containing precursors like cysteine].” The term “a compound” as understood by a POSITA does not need to be construed and can be given its plain and ordinary meaning.

134. However, I do want to note that the Patent Owner has alleged that Petitioner’s meat substitute products infringe the Challenged Claims, including the “compound” limitations, even though Petitioner’s products are not made using *free* cysteine, cystine, methionine, or thiamine. By “free,” I mean compounds of the sugars or sulfur-containing precursors that are not chemically bounded to another molecule or compound. In other words, Petitioner’s products are not mixed with,

for example, a solution containing free cysteine. Thus, Petitioner has taken the position that “a compound” is not limited to free compounds.

135. For example, pea flour contains cysteine because peas naturally contain cysteine. However, the cysteine in pea flour is not free cysteine but is instead bonded with other compounds within the pea flour. Thus, based on Patent Owner’s interpretation of the term “compound,” “a compound selected from cysteine” would be disclosed by pea flour, which contains cysteine.

136. Thus, based on Patent Owner’s interpretation, Grounds 1A-1C below (*see infra*, Section XI) map “a compound selected from cysteine” to pea flour. I note that even if Patent Owner’s interpretation of this term is not adopted, Grounds 1A-1C are unaffected because they also alternatively map the compound to Giacino’s composition, which contains cysteine and thiamine.

XI. GROUND 1A, 1B, 1C: BROWN, GIACINO, RONAI, ROLAN

137. As I explain below, Brown and Giacino render obvious claims 1-9 and 12-23 (Ground 1A). Brown, Giacino, and Ronai render obvious claims 2-3 (Ground 1B). Brown, Giacino, and Rolan render obvious claims 10-11 (Ground 1C).

A. **Ground 1A (Brown, Giacino)**

1. **Claim 1**

(a) **1[pre]: A meat-like-food product produced by a method comprising:**

138. To the extent the preamble is limiting, Brown and Giacino render obvious “[a] meat-like-food product produced by a method.”

139. Brown discloses a plant-based “meat *substitute* composition” *i.e.* a meat-like-food product, that “accurately mimics the taste, texture, or color of a meat product derived from animal sources.” EX1012(Brown), [0006]. Such compositions “may be made entirely from plant based sources.” *Id.*, [00273]. Such meat substitute compositions are “entirely composed of ingredients derived from non-animal sources, yet recapitulates key features associated with the cooking and consumption of an equivalent meat product derived from animals.” *Id.*, [00296]. Such products can include, in addition to other tissue replicas, “muscle replicas,” and one embodiment of Brown’s muscle replica comprises “pea flour, sunflower oil, and glucose” that is “heated for 10 minutes at 140C in the presence of... leghemoglobin (LHb)” to provide volatile compounds that “are often associated with the aroma of cooked meat.” *Id.*, [00364]; *see also Id.*, [00189] (describing “a meat substitute product” having “a muscle replica; a fat tissue replica; and a connective tissue replica” that “assembled in a manner that approximates the physical organization of meat”), [00191] (exemplary percentages of muscle, fat, and

connective tissue replicas), [00305]-[00311] (muscle replicas), [00312]-[00322] (fat replicas), [00323]-[00359] (connective tissue replicas). Hence, Brown discloses a meat-like food product.

(b) 1[a]: providing one or more plant proteins

140. In my opinion, Brown and Giacino render obvious “providing one or more plant proteins.”

141. Brown discloses an exemplary muscle replica that is prepared by mixing **pea flour**, sunflower oil, and glucose and then heating the mixture in the presence of leghemoglobin to provide volatile compounds that “are often associated with the aroma of cooked meat.” *Id.*, [00364]. A POSITA would understand that pea flour contains globulin proteins and albumin proteins from peas and therefore contains one or more plant proteins, *e.g.* pea proteins. *See, e.g.*, EX1067(Meng), 235 (“Like other legume seeds, pea seeds contain high amounts of protein (20–30%). Pea proteins mainly exist as **globulins** (65–80%).”).

142. Brown also discloses that “any of the ... muscle tissue replica[s] ... comprise one or more isolated, purified proteins,” *i.e.* a “protein component.” EX1012, [00299]. Such protein components “can comprise the 8S globulin from Moong bean seeds, or the albumin or globulin fraction of pea seeds,” *i.e.* plant proteins. *Id.*, [00307]. Such proteins could also be derived from “soybeans.” *Id.*,

[00300]. A POSITA would therefore understand that Brown teaches the muscle replica from [00364] can further include a bean seed or pea seed protein component.

(c) 1[b]: combining, with the one or more plant proteins: a composition comprising a heme-containing protein, wherein the composition comprises at least 60% of the heme-containing protein on a dry weight basis

143. In my opinion, Brown and Giacino render obvious “a composition comprising a heme-containing protein, wherein the composition comprises at least 60% of the heme-containing protein on a dry weight basis.”

144. As I discuss above, the term “comprises at least 60% of the heme-containing protein on a dry weight basis” does not have patentable weight. *See supra*, Section X.B. Hence, the prior art composition only needs to contain heme-containing protein to satisfy the claim limitation.

145. Brown discloses that its “muscle tissue replica further comprises one or more isolated and purified iron-containing proteins,” wherein “one or more isolated and purified iron-containing proteins is leghemoglobin.” EX1012(Brown), [0089], [0095].

146. Brown also discloses an exemplary muscle replica that is prepared by mixing pea flour, sunflower oil, and glucose and then heating the mixture in the presence of leghemoglobin to provide volatile compounds that “are often associated with the aroma of cooked meat.” *Id.*, [00364]. Leghemoglobin is a “heme-

containing protein.” *Id.*, [00373] (“A heme protein from the group of ... leghemoglobin ...”).

147. However, to the extent the dry weight percentage limitation is given patentable weight, Brown further discloses that the leghemoglobin composition comprises at least 60% of the heme-containing protein on a dry weight basis. For example, Brown teaches a “leghemoglobin purification flow” where the result was a composition with 78%, 83%, and 95% “purity ... of leghemoglobin” after each purification step. *Id.*, [00260].

148. Brown also discloses “a meat substitute composition comprising a protein content” wherein “one or more isolated and purified proteins accounts for **75% or more of said protein content by weight.**” *Id.*, [0006], [0010], [0011] (“90%” or more of said protein content by weight.”). Brown discloses “said one or more isolated and purified proteins are selected from the group consisting of leghemoglobin” *Id.*, [0018]. A POSITA would understand that these disclosures regarding purity and content by weight of the leghemoglobin refer to the dry weight percentage of said protein content.

(d) **1[c]: a compound selected from glucose, ribose, fructose, lactose, xylose, arabinose, glucose-6-phosphate, maltose, and galactose, and mixtures of two or more thereof; and**

149. In my opinion, Brown and Giacino render obvious this limitation.

150. Brown expressly discloses that the exemplary “muscle replica” includes glucose. EX10012(Brown), [00364] (“A **muscle replica comprising** pea flour, sunflower oil, and **glucose** was heated for 10 minutes at 140C in the presence of... leghemoglobin.”).

(e) **1[d]: a compound selected from cysteine, cystine, thiamine, methionine, and mixtures of two or more thereof in a concentration of at least 1.5 mM;**

151. **Brown Alone:** In my opinion, Brown discloses this limitation.

152. Brown discloses an exemplary muscle replica that is prepared by mixing **pea flour**, sunflower oil, and glucose and then heating the mixture in the presence of leghemoglobin to provide volatile compounds that “are often associated with the aroma of cooked meat.” *Id.*, [00364]. A POSITA would understand that pea flour includes cystine, methionine, and thiamine. Although pea flour is neither a compound nor a solution, for purposes of determining patentability of a product-by-process claim, it is my understanding that a prior art reference need only disclose a product that contains the same ingredients as the claimed product, *e.g.* the product need only contain cysteine.

153. For example, a peer-reviewed, scientific publication reveals that, like other legume flours, pea flour contains a host of amino acids, including specifically cystine and methionine:

	Soya	Chickpea	Lupin	Green pea
Cystine	1.5 ± 0.1	1.7 ± 0.1	1.4 ± 0.2	1.4
Methionine	1.4 ± 0.1	1.6 ± 0.1	0.7 ± 0.1	0.9
Threonine	4.1 ± 0.1	3.9 ± 0.2	4.2 ± 0.6	4.2
Valine	4.4 ± 0.4	4.2 ± 0.2	3.8 ± 0.3	4.4
Isoleucine	4.2 ± 0.2	4.1 ± 0.2	4.0 ± 0.4	3.9
Leucine	7.7 ± 0.4	7.7 ± 0.3	7.3 ± 0.7	7.1
Tyrosine	4.0 ± 0.5	2.7 ± 0.2	4.3 ± 0.9	3.6
Phenylalanine	5.0 ± 0.2	5.9 ± 0.4	4.0 ± 0.4	4.9
Lysine	6.0 ± 0.1	7.0 ± 0.3	4.9 ± 0.4	7.2
Tryptophan	1.5 ± 0.1	1.4 ± 0.1	1.0 ± 0.3	0.7
Asparaginic acid/ Asparagine	11.8 ± 0.1	12.1 ± 0.4	10.7 ± 0.7	12.2
Serine	5.5 ± 0.2	5.6 ± 0.2	5.6 ± 0.4	5.6
Glutaminic acid/ Glutamine	18.2 ± 0.4	17.1 ± 0.4	21.5 ± 1.6	19.7
Glycine	4.4 ± 0.2	4.3 ± 0.1	4.4 ± 0.5	4.8
Alanine	4.7 ± 0.2	4.5 ± 0.1	3.8 ± 0.5	4.4
Histidine	2.7 ± 0.2	2.7 ± 0.1	2.8 ± 0.5	2.5
Arginine	7.8 ± 0.2	9.2 ± 0.5	11.2 ± 1.1	8.6
Proline	5.3 ± 0.8	4.4 ± 0.4	4.4 ± 0.5	3.9

Tab. 2: Amino acid content of the examined legume flours
(% total protein)

EX1050/1059(Jahreis), 39 (Table 2). The same paper also recognizes that legumes, such as peas, are also a rich source of thiamine (*i.e.*, vitamin B₁). *See id.*, 41 (“[L]egumes are rich in **vitamin B₁** (**ca. 0.5 mg/100 g**), vitamin B₂ (0.3–0.5 mg/100 g), and folate (200–400 µg/100 g).”).

154. Another study that set out to “investigate amino acid content, biological value and dietary fibre content of conventional and organic pea (*Pisum sativum* L.) ... flours” similarly revealed that pea flour contains methionine. EX1057(Krumina-Zemture), 86 (Table 2) (indicating that conventional pea flour (CPF) contains 0.16

g methionine per 100 g, and organic pea flour (OPF) contains 0.15 g per 100 g); 85 (defining “CPF” as conventional pea flour and “OPF” as organic pea flour).

155. These findings are consistent with the U.S. Department of Agriculture nutritional information on raw peas, which reveals that raw peas contain cystine, thiamine, and methionine. EX1106(FDA), 3, 6-7. A POSITA would understand that pea flour is made by grinding dried peas until a fine powder is obtained. A POSITA would recognize that this process does not remove the amino acids and vitamins present in the raw peas, including cystine, methionine, and thiamine.

156. As I discussed above, in my opinion, the 1.5% mM concentration is a limitation that lacks patentable weight. As I also discussed above, Patent Owner appears to be interpreting “compound” to not be limited to free sulfur-containing precursors. As a result, the mere presence of cystine, methionine, and thiamine within the pea flour discloses this limitation.

157. **Brown and Giacino:** In the alternative, Giacino discloses several “novel artificial meaty flavoring compositions” that consist of cysteine and thiamine. EX1015(Giacino), 1:19-20. One of the exemplary embodiments, Example VI, has the ingredients listed below, including “L-cysteine hydrochloride” and “Thiamine hydrochloride.” *Id.*, 10:3-8.

Ingredient:	Parts by weight
L-cysteine hydrochloride -----	3.52
Hydrolyzed vegetable protein -----	154.70
Thiamine hydrochloride -----	3.52
Water -----	336.50
Taurine -----	10.00

158. L-cysteine hydrochloride and Thiamine hydrochloride are the “acid addition salt” forms of cysteine and thiamine. EX1015(Giacino), 5:66-68. They are a compound that consists of cysteine or thiamine molecules mixed with one molar equivalent of hydrochloride (HCl) molecules. EX1142(PubChem, L-Cysteine hydrochloride); EX1143(PubChem, Thiamine hydrochloride). The cysteine or thiamine are not molecularly bound to the hydrochloride and thus are free molecules. Thus, Giacino discloses a compound consisting of cysteine and thiamine, as claimed in this limitation.

159. Giacino notes that the ingredients of the Example VI embodiment are “refluxed for four hours” and “aged for three days.” EX1015(Giacino) 9:72-73. Gum arabic is also used as a “binding agent” in order to dry the composition, but Giacino notes that this step is optional. *Id.*, 6:44-45.

160. In my opinion, it would have been obvious to a POSITA to combine Brown’s meat substitute product with Giacino’s meat-flavor compositions.

161. Brown and Giacino are analogous art to the ’241 patent. For example, a POSITA would have understood that these references are in the same field of endeavor as the claimed invention. Like the ’241 patent, Giacino discloses various

meaty flavoring compositions that are added to other consumable food products. *See, e.g.*, EX1015(Giacino), 1:19-25, 1:65-68, 5:1-10, 7:15-26. Similarly, Brown strives to create compositions that more accurately mimic the flavor of conventionally obtained meat. In particular, as in the '241 patent, Brown teaches the use of heme-containing proteins, such as soy leghemoglobin, to enhance the meaty flavor and aroma of its compositions. *See, e.g.*, EX1012(Brown), [00364]. Additionally, like the '241 patent, both Giacino and Brown describe formulations for flavoring compositions that contain flavor precursors that when heated undergo reactions that produce meaty flavors and aromas. Also, the compositions described therein do not contain conventionally obtained meat.

162. A POSITA would have been motivated to combine Brown and Giacino in view of the well-known properties of cysteine and thiamine for enhancing meat flavors. Brown itself notes that “meat replica[s]” containing “amino acids” result in “[c]haracteristic flavor and fragrance components ... similar[] to meat.” EX1012(Brown), [00361], [00294]. Giacino similarly teaches that “meat-like flavors are well-known” and there is “[c]onsiderable demand for meat-flavored products” without meat. EX1015(Giacino), 1:26-31. Giacino’s “novel flavor compositions” thus provide “a marked meat flavor.” *Id.*, 2:47-48. Such compositions “can be used ... in a wide range of food stuffs ... as an aid in improving and enhancing existing flavor.” *Id.*, 1:65-67. Giacino especially notes that cysteine

was known to be “highly desirable” for adding meat flavor, although Giacino explains that one of the novelties of its compositions that beef flavor can be achieved with “small amounts of cysteine.” *Id.*, 4:47-49, 5:17-18.

163. Indeed, a POSITA would have been well aware of the importance of sulfur-containing precursors, especially cysteine and thiamine, for producing meat flavors. This had long been known in the industry. *Natural and Simulated Meat Flavors (With Particular Reference to Beef)* (“MacLeod”) was published in the Critical Reviews in Food Science & Nutrition journal in 1981. This paper would have provided a POSITA at the time of the invention a comprehensive overview of natural and simulated meat flavorings and the techniques and processes that were commonly employed to prepare food flavor additives having a meaty flavor and aroma.

164. MacLeod lists a host of volatile compounds that are known components of “natural beef aroma” in Table 1. EX1024(MacLeod), 313-356 (Table 1). MacLeod teaches that “Maillard reactions involving cysteine and/ or cystine have been extensively studied” and that the volatile compounds produced in these reactions include “several members listed in Table 1,” *i.e.*, those having a natural beef aroma. *Id.*, 381-382. Also notes that thiamine is, “*in particular*,” also a “meat aroma precursor.” *Id.*, 367; *see also id.* 409 (“Several patents stress the importance of thiamin as a meat flavor precursor”).

165. Indeed, more than half of the volatile reaction products of glucose and cysteine listed in Table 14 of MacLeod were known to have a natural beef aroma. *Compare id.*, 313-356 (Table 1) *with id.*, 384 (left column in Table 14) (both tables including at least ethanol, acetic acid, propanal, hexanal, butanone, benzene, toluene, m-xylene, p-xylene, furfural, 5-methyl-2-furfural, 2-acetylfuran, 2-acetyl-5-methylfuran, pyridine, methylpyrazine, 2,5-dimethylpyrazine, 2,5-dimethyl-3-ethylpyrazine, methanethiol, thiophen, 2-methylthiophen, 3-methylthiophen, 2-ethylthiophen, 2,3-dimethylthiophen, 2,5-dimethylthiophen, 2-acetylthiophen, 2-propionylthiophen).

166. MacLeod further explains that starting in the 1960s, researchers tasked with creating synthetic meat flavorings recognized “the importance of reducing sugars and amino acids and the significance of the Millard reaction.” EX1024(MacLeod), 399. From this understanding a myriad of “reaction products” were created (and patented). *Id.* MacLeod recounts how the very first of these, issued to “Morton” in 1960 (G.B. 836,694), identified ***cysteine*** as an amino acid of particular significance (alone or in combination with other amino acids) for a reaction with a reducing sugar, such as glucose, to produce a flavoring agent having a meat-like flavor and aroma. *Id.*; EX1044(Morton), 1:9-2:70, 3:5-13. MacLeod emphasizes the role cysteine has played as the amino acid of choice in flavoring additives. EX1024(MacLeod), 399 (“[*An Introduction to Synthetic Meat Flavors*]

stressed the relevance of amino acids (in particular *cysteine*)” in creating beef flavors), 399 (“Whenever *cysteine* was used, recognizable beef aroma resulted...”), 407 (“They therefore concluded that reaction between a reducing sugar and a “sulfur-donor” such as *cysteine* was important in addition to the already recognized Millard reaction.”), 407 (“More complete beef flavors were obtained when several amino acids (**always including *cysteine***) were heated with a reducing sugar.”).

167. Based on at least the above teachings, as well as the knowledge of a POSITA, a POSITA would have been motivated to add Giacino’s cysteine and thiamine-containing beef-flavored composition to enhance the meat flavor of Brown’s meat substitute product, given the well-known properties of cysteine and thiamine. Brown invites the addition of amino acids and recognizes the desirability of meat flavor, and Giacino provides compositions that achieve meat flavor via cysteine and thiamine. Combined with the glucose found in Brown’s products, a POSITA knew this combination would create a more desirable meat flavor when cooked. EX1005(McGorin), Section VII; EX1015(Giacino), 6:3-7 (“The presence of [ribose, sucrose, dextrose (i.e. glucose)] results in ... more intense flavor characteristics.”).

168. A POSITA would have had a reasonable expectation of success in combining the teachings of Brown and Giacino. A POSITA would have a reasonable expectation of success given the specific instructions provided by

Giacino in preparing its compositions. EX1015(Giacino), 9:70-10:14 (providing instructions for Example VI). A POSITA would reasonably expect that following the specific instructions in Giacino would result in a meat flavoring compound that could successfully be added to Brown's muscle replica and result in additional beef flavoring. Indeed, adding Giacino's beef-flavor compounds was simply the application of a known technique to a known product ready for improvement, yielding the predictable result of enhanced meat flavor.

169. **Cysteine and Thiamine Concentration:** As I opined above, the limitation "in a concentration of at least 1.5 mM" should not be given any patentable weight, thus the combination of Brown and Giacino renders obvious this limitation merely by the presence of cysteine and thiamine in the final product.

170. However, to the extent the concentration is given patentable weight, Giacino's Example VI discloses the claimed concentrations for both cysteine and thiamine.

171. The unit of measurement for concentration used in the patent is "mM," which is an abbreviation for millimolars. Millimolars represents the number of millimoles of a molecule per liter of a solution. A millimole is 1/1000 of a mole, and a mole measures the amount of a molecule. Each molecule has a different weight/mass per molecule, which is known as molecular weight and is measured in grams per mole. Because the molecular weight of sulfur-containing precursors like

cysteine and thiamine are well-known, millimolar concentrations can be calculated from disclosures of the sulfur-containing precursors when measured in grams.

172. Concentration as measured in millimolars is referred to as molarity or molar concentration. Molarity measures the concentration of a **solution**, *i.e.* a solute (e.g. cysteine or thiamine) dissolved in a solvent (e.g. water). Thus, a POSITA would understand that the limitations are referring to a molar concentration of a solution containing one of the claimed sulfur compounds.

173. A POSITA would generally understand the concentration of the solution to be measuring the concentration of the solute and the solvent, measured in liters. In other words, a POSITA would not include other solutes within the solution. To put it another way, the denominator for calculating the concentration would be the volume of the solute (e.g. cysteine) and the solvent (e.g. water), even if the solution may have other solutes (e.g. thiamine).

174. However, for the sake of completeness, I will also discuss the concentration of cysteine and thiamine treating the solution as a whole. In other words, as an alternative calculation, I will use the volume of the entire solution (*i.e.* the volume of the cysteine hydrochloride, thiamine hydrochloride, water, hydrolyzed vegetable protein, and taurine) as the denominator for calculating the concentration.

175. Giacino's Example VI lists L-cysteine hydrochloride and thiamine hydrochloride each at "3.52" "parts by weight." EX1015(Giacino), 10:4-6. The

ingredient list has a total of 508.24 parts by weight, and is a solution with multiple solutes (cysteine hydrochloride, hydrolyzed vegetable protein, thiamine hydrochloride, and taurine) with a single solvent (water). Thus, in 1 kilogram of solution, the amount of cysteine hydrochloride and thiamine hydrochloride is 6.926 grams each.

176. A POSITA would understand that cysteine hydrochloride consists of cysteine and hydrochloride molecules and has a molecular weight of 157.62 g/mol. EX1142(PubChem, L-Cysteine hydrochloride). As mentioned, the cysteine or thiamine are not molecularly bound to the hydrochloride and thus are free molecules. A POSITA would also understand that cysteine has a molecular weight of 121.16 g/mol (grams per mole). EX1108(PubChem, L-Cysteine). (Indeed, the sum of cysteine's molecular weight and hydrochloride's molecular weight equals cysteine hydrochloride's molecular weight.) Thus, cysteine is 76.87% of the total mass of cysteine hydrochloride, *i.e.* 6.926 grams of cysteine hydrochloride equals 5.324 grams of cysteine. Since a POSITA knows that 121.16 grams of cysteine equals 1000 millimoles of cysteine, 5.324 grams of cysteine equals 44 millimoles of cysteine.

177. Similarly, a POSITA would understand that thiamine hydrochloride comprises thiamine and hydrochloride molecules (and chlorine atoms). Thiamine hydrochloride has a molecular weight of 337.3 g/mol. EX1143(PubChem, Thiamine

hydrochloride). Thiamine alone has a molecular weight of 265.36 g/mol. EX1110(PubChem, Thiamine). (Indeed, thiamine hydrochloride's molecular weight is the sum of the molecular weights of thiamine and hydrochloric acid, and the atomic weight of one chlorine atom). Thus, thiamine is 78.67% of the total mass of thiamine hydrochloride, *i.e.* 6.926 grams of thiamine hydrochloride equals 5.45 grams of thiamine. Since a POSITA knows that 265.36 grams of thiamine equals 1000 millimoles of thiamine, 5.45 grams of thiamine equals 20.5 millimoles of thiamine.

178. Now that we know how many millimoles of cysteine and thiamine are in 1 kg of solution, we next calculate the volume to use as a denominator. As I discussed above, a POSITA would generally understand that the concentration of a compound in a solution only considers the solute (e.g. cysteine) and solvent (e.g. water). In that case, the amount of water (336.50 parts by weight) in the 1 kg of solution is about 662.1 grams, *i.e.* 0.6621 liters of water. Although the solute itself adds volume, the amount is insignificant such that it would largely have little effect on the molarity. For example, cysteine has a density of about 1.3 grams per milliliter (*ie.* 0.001 liter). EX1108(Pubchem, L-Cysteine). Thus, 5.324 grams of cysteine is about 4.1 milliliters (or .0041 liters), which is insignificant compared to the water's 0.6621 liters. Whether or not the volume of the solution includes cysteine's 0.0041 liters, the molarity is still about 66 mM.

179. Similarly, 20.5 millimoles (5.45 grams) of thiamine in 0.6621 liters of water is a molarity of about 31 mM. Both of these values exceed the claimed 1.5 mM.

180. If one were to use all of the ingredients of the solution, here are the respective densities and volumes for each ingredient: (1) cysteine hydrochloride has a density of 1.53 g/ml (EX1152 (Safety data sheet, L-Cysteine hydrochloride), 8), and thus in 1 kg of Giacino's solution, 6.926 grams has a volume of 4.527 ml, (2) thiamine hydrochloride has a density of 0.4 g/ml (EX1153 (Safety data sheet, Thiamine hydrochloride), 8), thus 6.926 grams has a volume of 17.3 ml, (3) taurine has a density of 1.72 g/ml (EX1154(Safety data sheet, Taurine), 6), thus 19.7 grams has a volume of 11.45 ml, (4) hydrolyzed vegetable protein's density depends on the particular HVP product (such as whether it is a powder or a liquid, and which protein it is derived), but a typical density of powders is about 0.7 or 0.8 g/ml, thus a volume of about 380-430 ml. Water's density is 1 g/ml, and thus 662.1 grams is a volume of 662.1 ml. The total volume of the solution is about 1100 ml, or 1.1 liters. For 44 millimoles of cystine, this is a concentration of about 40 mM, and for 20.5 millimoles of thiamine, this is a concentration of about 19 mM, both of which exceed 1.5 mM.

(f) 1[e]: wherein the meat-like food product is free of animal heme-containing protein;

181. In my opinion, Brown and Giacino render obvious this limitation.

182. Brown discusses the health and environmental drawbacks to a meat containing diet. EX1012(Brown), [0001]-[0003]. To promote the adoption of meat-free products as an alternative to meat, Brown discloses a “meat substitute composition [that] accurately mimics the taste, texture, or color of a meat product derived from animal sources.” *Id.*, [0006]. Brown explains that different tissue replicas comprise the meat substitute composition, including a “muscle replica.” *Id.*, [00189]. The muscle replica can include proteins that are from non-animal sources, including plants and genetically modified yeast or bacteria. *Id.*, [00192]-[00195].

183. One exemplary “muscle replica” described in [00364] includes pea flour, sunflower oil, glucose, and leghemoglobin. Brown does not disclose that any of these ingredients are sourced from animals.

184. A POSITA would also understand that pea flour and sunflower oil are produced from non-animal sources (peas and sunflower seeds, respectively). Leghemoglobin is also not from an animal as it is an oxygen-carrying phytohemoglobin found in the nitrogen-fixing root nodules of leguminous plants, such as soy. *See* EX1073(Santana), 1259 (discussing how leghemoglobin present in the root nodules of leguminous plants facilitates oxygen diffusion to bacteroids responsible for expressing nitrogenase). Indeed, Brown describes (at length) methods for obtaining leghemoglobin from plants and genetically modified yeast or bacteria engineered to produce such non-animal proteins. *See* EX1012(Brown), [00376]-[00383].

185. Glucose is a simple sugar. A POSITA would have understood that glucose is conventionally derived from plant starches, such as from corn, wheat, and potato. EX1089(Yebra-Biurrun), 479 (“Glucose...is the major product from starch hydrolyzed by acid and/or enzymes. The major starch source in the USA and Japan is corn (*Zea mays*) and in Europe, wheat and potato.”).

186. Giacino’s meat flavoring compositions do not contain animal products. A POSITA would understand that Giacino teaches, as one example, a meaty flavoring composition that includes thiamine, taurine, vegetable protein hydrolysate, cysteine, and a monosaccharide, such as ribose. *See* EX1015(Giacino), 2:5-8 (“[T]he invention, in its broad aspect involves heating a mix composition comprising **taurine and thiamine** at an elevated temperature for a period of time whereby a meaty flavor is developed.”), 2:53-60 (“development of a variety of flavors is achieved in separate compositions by providing in the pre-mix...a quantity of a source of one or more amino acids such as...**hydrolysates**”), 3:23-25 (“**vegetable hydrolysates**, such as those obtained from corn, wheat, yeast and the like are preferred”), 3:43-46 (“...additionally present in the pre-mix composition small quantities of a sulfur containing amino acid such as **cysteine**...”), 6:1-4 (“[T]here may be added to the pre-mix a quantity of a saccharide material such as...**[r]ibose**.”); *see also id.*, 5:1-10 (disclosing the use of **thiamine** and **taurine** and optionally **hydrolyzed protein and cysteine**).

187. Giacino expressly discloses that for the hydrolyzed protein ingredient, non-animal, plant-based hydrolysates are preferred. *See id.*, 3:23-25 (“vegetable hydrolysates, such as those obtained from corn, wheat, yeast and the like are preferred”). With respect to thiamine, Giacino expressly teaches that it is sourced from yeast. *Id.*, 5:68-70.

188. As to cysteine, ribose, and taurine, Giacino does not disclose that these compounds are directly sourced from previously live animals. Hence, a POSITA would understand that Giacino allows for the use of cysteine, ribose, and taurine from non-animal sources.

189. Nor do these compounds have to be obtained from a previously live animal. A POSITA would have understood that it would have been obvious to use cysteine, ribose, and taurine that were obtained from non-animal sources. For example, it was well-known in the art that cysteine could be obtained from non-animal sources, including synthetic cysteine made in recombinant microorganisms. *See generally* EX1085(Wacker); EX1078(Reutter-Maier); EX1079(Leinfelder). Similarly, it was well-known that taurine is derived synthetically from, for example, ethylene oxide or monoethanolamine. *See generally* EX1081(Hu); *see also id.*, 1:5-29 (“Many chemical synthetic methods have been known in the prior arts for the preparation of taurine and related derivatives. The following two methods have been used in industry to manufacture over 50,000 tons of taurine per year, starting from

ethylene oxide (the EO process) and monoethanolamine (the MEA process).”). Ribose too is derived synthetically from, for example, xylose. *See generally* EX1080(Feniou); *see also id.*, 1:46-49 (“D-ribose can be synthesized from D-xylose, a monosaccharide which is widely distributed in the vegetable kingdom in the form of xylans.”).¹

190. A POSITA would have been motivated to use non-animal sourced cysteine, taurine, and ribose to keep the meaty flavoring composition (and thus the food product to which it is ultimately added) free of animal products for those individuals that refrain from consuming animal products in their diet for health, environmental, ethical, or religious reasons. Using non-animal sourced cysteine, taurine, and ribose is also consistent with Giacino’s teachings that “[t]here is considerable demand for meat-flavored products in which the actual meat such as beef, pork, chicken, turkey, duck and the like...is actually undesirable.” EX1015(Giacino), 1:27-30.

(g) 1[f]: wherein cooking the meat-like-food-product results in the production of at least two volatile compounds which have a meat-associated aroma; and

191. In my opinion, Brown and Giacino render obvious this limitation.

¹ A POSITA would understand that “D-ribose” refers to the D configuration of ribose, which is its naturally occurring form.

192. Brown discloses an exemplary muscle replica that is prepared by mixing pea flour, sunflower oil, and glucose and then heating the mixture in the presence of leghemoglobin to provide volatile compounds that “are often associated with the aroma of cooked meat.” EX1012(Brown), [00364]. Brown expressly teaches that upon heating this muscle replica composition, various compounds associated with the aroma of cooked meat were detected during testing, including 2-octanone and 2-methyl furan. *Id.* Hence, Brown discloses “wherein cooking the food flavor additive composition results in the production of at least two volatile compounds which have a meat-associated aroma.”

(h) **1[g]: wherein the meat-like food product is in a form selected from the group consisting of a hotdog, a burger, ground meat, a sausage, a steak, a filet, a roast, a meatball, a meatloaf, or bacon.**

193. In my opinion, Brown and Giacino render obvious this limitation.

194. Brown discloses that “[t]he consumables of the present invention can compete with, supplement or replace animal based foods” and that they “may be visually similar to or indistinguishable from **ground beef** or **a particular cut of beef.**” *Id.*, [00272]. Brown’s “consumables” include its meat substitute products. *Id.*,

2. Claim 2

195. In my opinion, Brown discloses “[t]he meat-like-food product of claim 1, wherein the one or more plant proteins comprise a textured vegetable protein.”

196. Brown discloses that its “muscle replica” is “entirely derived from non-animal sources” and that it “comprises fibers that are to some extent organized isotropically,” wherein the “fibers comprise a protein component.” *Id.*, [00305]-[00306]. Brown further discloses that the “protein component comprises one or more isolated, purified proteins,” such as “the albumin or globulin fraction of pea seeds” which are “examples of proteins with favorable properties for constructing meat replicas because of their ability to form gels with **textures similar to animal muscle or fat tissue.**” *Id.*, [00307].

197. Brown also discloses that “the present invention provides for methods for producing asymmetric or spun **protein fibers.**” *Id.*, [00310]. Brown discloses that these “fibers are formed by extrusion of the protein component through an extruder.” *Id.* A POSITA would understand that the formation of fibers through an extrusion of the protein component would result in a textured protein.

3. Claim 3

198. In my opinion, Brown discloses “[t]he meat-like-food product of claim 2, wherein the textured vegetable protein is textured soy protein.”

199. Brown discloses that the protein components in its meat replicas are sourced from “soy or pea plants.” *Id.*, [0049]; *see also id.*, [00300].

4. Claim 4

200. In my opinion, Brown discloses “[t]he meat-like-food product of claim 1, wherein the composition comprising the heme-containing protein comprises at least 70% of the heme-containing protein on a dry weight basis” for the same reasons discussed above for limitation 1[b].

5. Claim 5

201. In my opinion, Brown discloses “[t]he meat-like-food product of claim 1, wherein the composition comprising the heme-containing protein comprises at least 80% of the heme-containing protein on a dry weight basis” for the same reasons discussed above for limitation 1[b].

6. Claim 6

202. In my opinion, Brown discloses “[t]he meat-like-food product of claim 1, wherein the heme-containing protein is a globin.” A POSITA would understand that a leghemoglobin is a globin.

7. Claim 7

203. In my opinion, Brown discloses “[t]he meat-like-food product of claim 1, wherein the heme-containing protein comprises an amino acid sequence having at least 80% sequence identity to a polypeptide set forth in SEQ ID NOs. 1-26.”

204. The '241 patent identifies SEQ ID NO 4 as a leghemoglobin from *glycine max* (*i.e.*, soybean). EX1001, 10:40-41. Brown discloses that the leghemoglobin added to its compositions is derived from soy. *See* EX1012(Brown),

[00376]-[00377], [00380]-[00381]. Hence, a POSITA would understand that Brown's soy leghemoglobin would have at least an 80% sequence identity to claimed SEQ ID NO 4.

205. The patent identifies the specific amino acid sequence for SEQ ID NO:4 (*glycine max*) as follows:

```
<210> SEQ ID NO 4
<211> LENGTH: 145
<212> TYPE: PRT
<213> ORGANISM: Glycine max

<400> SEQUENCE: 4

Met Gly Ala Phe Thr Glu Lys Gln Glu Ala Leu Val Ser Ser Ser Phe
 1             5             10             15

Glu Ala Phe Lys Ala Asn Ile Pro Gln Tyr Ser Val Val Phe Tyr Thr
      20             25             30

Ser Ile Leu Glu Lys Ala Pro Ala Ala Lys Asp Leu Phe Ser Phe Leu
      35             40             45

Ser Asn Gly Val Asp Pro Ser Asn Pro Lys Leu Thr Gly His Ala Glu
      50             55             60

Lys Leu Phe Gly Leu Val Arg Asp Ser Ala Gly Gln Leu Lys Ala Asn
      65             70             75             80

Gly Thr Val Val Ala Asp Ala Ala Leu Gly Ser Ile His Ala Gln Lys
      85             90             95

Ala Ile Thr Asp Pro Gln Phe Val Val Val Lys Glu Ala Leu Leu Lys
      100            105            110

Thr Ile Lys Glu Ala Val Gly Asp Lys Trp Ser Asp Glu Leu Ser Ser
      115            120            125

Ala Trp Glu Val Ala Tyr Asp Glu Leu Ala Ala Ala Ile Lys Lys Ala
      130            135            140

Phe
145
```

EX1001, cols. 47-49.

206. Converting the above three-letter amino acid abbreviations to single-letter designations results in the following sequence:

MGAFTEKQEA LVSSSFEAFK ANIPQYSVVF YTSILEKAPA
AKDLFSFLSN GVDPSNPFLT GHAEKLFGLV RDSAGQLKAN
GTVVADAALG SIHAQKAITD PQFVVVKEAL LKTIKEAVGD
KWSDELSSAW EVAYDELA AAA IKKAF

207. Brown discloses an exemplary muscle replica that is prepared by mixing pea flour, sunflower oil, and glucose and then heating the mixture in the presence of **leghemoglobin** to provide volatile compounds that “are often associated with the aroma of cooked meat.” Brown, [00364]. Brown also discloses that the muscle replicas may comprise “iron-containing protein,” such as “leghemoglobin,” having “at least 98% homology to SEQ ID NO 1.” *Id.*, [0089]-[0091]. Brown defines SEQ ID NO 1 as having the following amino acid sequence:

comprises an amino acid sequence with at least 70% homology to SEQ ID NO 1. SEQ ID NO 1:

MVAFTEKQDALVSSSFEAFKANIPQYSVVFYTSILEKAPAAKDLFSFLANGVDPTNPFLTGHAEK
LFALVRDSAGQLKASGTVVADAALGTVHAQKAVTDPQFVVVKEALLKTIKAAVGDKWSDELS
RAWEVAYDELA AAA IKKA. In a particular embodiment, said one or more isolated and purified iron-

Id., [0091].

208. A POSITA would recognize that the SEQ ID NO 1 identified in Brown is substantially similar to SEQ ID NO 4 (leghemoglobin of *glycine max*) identified in the '241 patent. Indeed, the minor differences between these two amino acid sequences are shown below with the highlighted amino acid residue designations in parentheses corresponding to the amino acid residue replacements found in Brown.²

² “Delete” means the amino acid is not present in Brown.

MG(V)AFTEKQE(D)A LVSSSF EAFK ANIPQYSVVF YTSILEKAPA
 AKDLFSFLS(A)N GVDPS(T)NPKLT GHAEKLFG(A)LV
 RDSAGQLKAN(S) GTVVADAALG SI(V)HAQKAI(delete)TD
 PQFVVVKEAL LKTIKE(A)AVGD KWSDELSS(R)AW EVAYDELAAA
 IKKAF(delete)

209. Hence, a POSITA would recognize that 11 amino acid residues are different out of the 145 amino acid residues making up SEQ ID NO 4 (*glycine max*) identified in the '241 patent. This means that the amino acid sequence identified in Brown (*i.e.*, SEQ ID NO 1) has about 92% homology with SEQ ID NO 4 (*glycine max*) in the '241 patent.

210. This result was substantially confirmed using the National Library of Medicine's BLAST® tool where a comparison of these two amino acid sequences reveals that they have 93% homology. *See* EX1101(BLAST), 3.

211. This value (92-93% homology) is greater than the minimum 80% homology required by claim 7. Accordingly, a POSITA would understand that Brown discloses that the leghemoglobin used in its muscle replicas can have at least 80% sequence identity to the leghemoglobin protein found in *glycine max* (*i.e.*, SEQ ID NO 4 of '241 patent).

8. Claims 8-9

212. In my opinion, Brown discloses “[t]he meat-like-food product of claim 1, wherein the cysteine is added to a concentration of about 0.8 mM to about 10 mM.” Brown also discloses “[t]he meat-like-food product of claim 1, wherein the

thiamine is added to a concentration of about 0.1 mM to about 2 mM.” As I explained above, these limitations should not be given patentable weight, and thus the claims are met simply by the presence of cysteine or thiamine in the food product. Thus Brown discloses claims 8 and 9 for the same reasons it discloses claim 1, specifically limitation 1[d], wherein the pea flour contains cysteine and thiamine. Brown and Giacino also render obvious these claims, since Giacino’s beef-flavor compound includes cysteine and thiamine.

213. However, to the extent the limitations are given patentable weight, Giacino does teach that “[i]t will be appreciated by those skilled in the art that variations in flavor can be obtained by altering ... the proportions ... of amino acids employed ... depend[ing] upon the personal preferences of the processor [and] consumer.” EX1015(Giacino), 3:31-36. Thus, Giacino provides “general guidelines,” for the amount of cysteine and thiamine that can provide “suitable” flavors, including “0.025 to 50 weight percent thiamine” and “0 to 2.5 weight percent cysteine.” *Id.*, 5:1-10. As discussed below, these ranges result in concentrations of cysteine and thiamine that overlap with the claimed ranges.

214. For cysteine, if one only considers the solvent and solute as the volume (*i.e.* 0.66 liters of solution for 1 kg of product (*see* limitation 1[d])), 0.8 mM is about 0.53 millimoles (*i.e.* 0.064 grams using cysteine’s molecular weight of 121.16 g/mol) of cysteine and 10 mM is about 6.6 millimoles (*i.e.* 0.8 grams) of cysteine for

1 kg of product. This constitutes 0.0064% to 0.08% of cysteine by weight, which is within Giacino's disclosed range of 0 to 2.5% of cysteine by weight.

215. Similarly, for thiamine using 0.66 liters of solution for 1 kg of product, 0.1 mM is about 0.066 millimoles (*i.e.* 0.018 grams using thiamine's molecular weight of 265.36 g/mol) of thiamine and 2 mM is about 1.32 millimoles (0.35 grams) of thiamine per 1 kg of product. This constitutes 0.0018% to 0.035% of thiamine by weight, which overlaps with Giacino's disclosed range of 0.025 to 50% of thiamine by weight.

216. If one were to consider the volume of the entire product as the solution (*i.e.* 1.1 liters of solution per 1 kg of product (*see* limitation 1[d])), 0.8 mM is about 0.88 millimoles (0.11 grams) of cysteine and 10 mM is about 11 mM (1.33 grams) of cysteine, which is 0.01% to 0.133% of cysteine by weight, which is again within Giacino's disclosed range of 0-2.5% for cysteine.

217. For thiamine when considering the entire volume of the product (1.1 liters per 1 kg of product), 0.1 mM is about 0.11 millimoles (0.03 grams) of thiamine and 2 mM is 2.2 millimoles (0.6 grams) of thiamine. This is 0.003% to 0.06% of thiamine by weight, which overlaps with Giacino's disclosed range of 0.025% to 50% of thiamine by weight.

218. I have been informed that a range disclosed in a prior art reference will anticipate a claimed range if it overlaps and the prior art range is disclosed with

sufficient specificity. In my opinion, Giacino's thiamine and cysteine ranges are disclosed with sufficient specificity. Giacino notes that a POSITA would appreciate that the amount of cysteine and thiamine can be altered, and provides suitable ranges to do so. Moreover, I note that the '241 patent places no particular importance on the specific concentration of cysteine and thiamine. Throughout the various examples of the '241 patent, to the extent a concentration of cysteine or thiamine (or indeed, any precursor) is disclosed, it is disclosed without discussion of what effect that particular concentration has on the final product. In fact, the '241 patent does not even disclose a range of concentration for cysteine and thiamine but instead simply provides examples. For cysteine, the examples of concentration it gives are 10, 5, and 0.8 mM, and for thiamine, it discloses examples of 2, 1, 0.5, and 0.1 mM. EX1001, 44:19; 28:36; 79:12. The '241 patent does not provide any explanation for the particular concentration chosen, or what difference the various concentrations would have on the final product.

219. I have also been informed that a claimed range can be obvious if discovering it was a matter of routine experimentation, and the modification does not result in surprising or unexpected. Giacino already teaches that it was well within a POSITA's knowledge to alter the amounts of cysteine and thiamine, and even provides preferred ranges of cysteine and thiamine that overlap with the claimed ranges. EX1015(Giacino), 3:31-36, 4:73. Thus, it would have simply been

a matter of routine experimentation for a POSITA to use an amount of cysteine or thiamine within Giacino's range that also falls within the claimed range. As I discussed above, the '241 patent places no importance on the claimed concentrations of cysteine and thiamine, and certainly does not discuss that it resulted in surprising or unexpected results.

9. Claim 12

220. In my opinion, Brown discloses “[t]he meat-like-food product of claim 1, further comprising combining with the one more plant proteins, one or more of a vegetable oil, an algal oil, sunflower oil, corn oil, soybean oil, palm fruit oil, palm kernel oil, safflower oil, flaxseed oil, rice bran oil, cottonseed oil, olive oil, canola oil, flaxseed oil, coconut oil, and mango oil.”

221. Brown discloses an exemplary muscle replica that is prepared by mixing pea flour, **sunflower oil**, and glucose and then heating the mixture in the presence of leghemoglobin to provide volatile compounds that “are often associated with the aroma of cooked meat.” EX1012(Brown), [00364].

10. Claim 13

222. In my opinion, Brown discloses “[t]he meat-like-food product of claim 1, further comprising combining with the one more plant proteins, one or more of acetic acid, lactic acid, glycolic acid, citric acid, succinic acid, tartaric acid, caprylic acid, capric acid, lauric acid, myristic acid, palmitic acid, palmitoleic acid, stearic

acid, oleic acid, linoleic acid, alpha linolenic acid, gamma linolenic acid, arachidic acid, arachidonic acid, behenic acid, and erucic acid.”

223. Brown discloses a meat substitute product comprising the use of a fat replica comprising fat droplets that are sourced from “plant sources” including “caprylic acid,” “capric acid,” “lauric acid,” “myristic acid,” “palmitic acid,” “palmitoleic acid,” “oleic acid,” “linoleic acid,” and “arachidonic acid.” *Id.*, [00315].

11. Claim 14

224. In my opinion, Brown and Giacino render obvious “[t]he meat-like food product of claim 1, wherein cooking comprises heating the meat-like food product at 150° C. for about 3 to about 5 minutes.”

225. As discussed above with respect to limitation 1[f], Brown discloses that cooking the meat product disclosed in [00364] “for 10 minutes at 140C” resulted in the volatile compounds “2-octanone” and “2-methyl” which “are often associated with the aroma of cooked meat.” A POSITA would have understood from this teaching that cooking the meat product for 3-5 minutes at a higher temperature 150C would likewise result in the same volatile compounds. Both the prior art heating step and the claimed heating step would trigger a Maillard reaction that would provide at least two volatile compounds having a meat-associated aroma. *See, e.g.*, EX1015(Giacino), 6:26-31.

226. Moreover, it is well within the skill of a POSITA to vary the temperature and cooking time of a meat-like-food product to achieve the resultant desired aroma/flavor profile of the composition. Given Brown's teaching of heating its muscle replica composition at 140° C, it would have been routine experimentation for a POSITA to adjust Brown's cooking temperature up or down to shorten or lengthen, respectively, the cooking time. In fact, nothing in the '241 specification leads to the opposite conclusion because there is no disclosure as to the criticality of cooking at (or above) 150° C.

227. Additionally, a POSITA would have known that temperature plays an important role in influencing the flavor/aroma produced by the Maillard reaction. *See* EX1005(McGorin), ¶¶57-58. Notably, a POSITA would have understood that different pathways of flavor formation have different activation energies. *See id.*, ¶59. For example, flavor pathways that cause the formation of pyrazines have a high activation energy. *Id.*; EX1033(Reineccius), 106-107 (Figure 5.3 showing the influence of temperature on the rate of formation of pyrazines; significantly more pyrazines are formed at temperatures greater than 150° C). This means that the amount of these volatiles produced significantly increases with greater temperatures. A POSITA would have also known that pyrazines are associated with the aroma of cooked meat, and, in particular, contribute roasted, nutty, and toasted notes. *See, e.g.*, EX1024(MacLeod), 344 (Table 1: pyrazine is a volatile component of "natural

beef aroma”), 358 (“basic fraction may contribute to roasted beef aroma and normally contains pyrazines...”), 384-385 (Tables 14 and 15 identifying various pyrazines that are produced when reacting cysteine, glucose, and ribose); EX1026(Dwivedi), 493 (identifying pyrazine and various derivatives as volatiles associated with heat-treated beef); EX1033(Reineccius), 107 (“These high activation energies indicate a very strong temperature dependence of pyrazine formation and explain why most pyrazines (roasted, nutty, toasted notes) are not formed during storage but only during high temperature treatment.”).

228. Having this basic knowledge, a POSITA would have known that raising Brown’s heating temperature to or above 150° C would have resulted in the production of more pyrazines (than heating at 140° C), which were known to be associated with “roasted, nutty, toasted” flavor notes. A POSITA would have been motivated to do so where the muscle replica was desired to be used to mimic roast beef or otherwise impart roasted/toasted notes to the food to which it was being added. To compensate for the higher temperature, a POSITA would have known to reduce the cooking time down from the 10 minutes disclosed by Brown to 3-5 minutes. *See* EX1012(Brown), [00364]. A POSITA would have had a reasonable expectation of success because this would have required only ordinary skill (*e.g.*, raising temperature of heating apparatus), and the increased production of pyrazines

at temperatures exceeding 150° C was documented. *See* EX1033(Reineccius), 107 (Figure 5.3).

229. Giacino also discloses this limitation. As discussed above, a POSITA would be motivated to combine Brown and Giacino to add its flavor precursors to Brown. *See supra*, Section XI.A.1 (limitation 1[d]). A POSITA would be further motivated to incorporate Giacino's teachings regarding cooking temperature and time when adding in flavor precursors to impart a beefy flavor and aroma. Indeed, as discussed below, Giacino's teachings describe at which temperatures and cooking durations its compositions will result in flavor and aroma. Thus, these are teachings describing properties of Giacino's compositions that meet the claimed properties that cooking the product results in volatile compounds.

230. Giacino teaches that its meat-flavored compositions resulted in reactions when cooked between 200° F (*i.e.*, 93° C) and 420° F (*i.e.*, 216° C), for a duration that ranged from 0.25 minutes to 6 hours. EX1015(Giacino), 6:15-31. Giacino further explains that when heat exchangers are used, "the reaction mixture can quickly be brought to the reaction temperature and then quickly cooled in a second exchanger to a lower temperature at which no further reaction will take place." *Id.*, 6:48-52; *see also id.*, 6:68-71 (temperatures between 250°F (121°C) and 400°F (204°C) and heating times between 15 seconds and 3 minutes are preferred for heat exchangers). *Id.*, 6:68-71.

231. Giacino's range overlaps with the claimed range of 3-5 minutes at 150°

C. In my opinion, Giacino's range is provided with sufficient specificity, because Giacino provides a specific range of temperatures and cooking durations that result in a Maillard reaction and the release of flavors. Moreover, the '241 patent does not place any importance on the claimed temperature or cooking duration. The '241 patent simply discloses that its exemplary patties were heated at 150° C for 3 or 5 minutes without any discussion of what importance that particular temperature or particular duration had on the release of reactions, and how it may have differed from other temperatures or durations. *See, e.g.*, EX1001('241 patent), 21:19, 22:18, 23:22-23, 23:27, 25:4, 25:36-37, 26:6, 26:38, 27:8-9, 28:42-43, 37:49, 41:33.

232. Giacino teaches that the temperature and duration can be altered to achieve "the desired flavor development." EX1015(Giacino), 6:28-39. This teaching shows that cooking temperatures and duration are routine experimentation, and well within the skill of a POSITA to adjust, and there is no indication that surprising or unexpected results will result from the claimed temperature and time, as a POSITA would understand would be fully expected to achieve the expected result of a Maillard reaction and release of the same volatile compounds. EX1005(McGorin), Section V.B.

233. A POSITA would also have considered it obvious to try cooking Brown's composition at 150°C for 3-5 minutes in view of the ranges disclosed by

Giacino. Giacino's range of temperatures and durations are a finite number that of predictable temperatures and durations for cooking meat (*i.e.* producing volatiles that lead to meaty flavors and aromas). A POSITA would have reasonably expected the result of a Maillard reaction and release of volatile compounds.

234. Thus, Giacino discloses the claimed range and the combination of Brown and Giacino renders it obvious.

12. Claim 15

235. In my opinion, Brown discloses "[t]he meat-like-food product of claim 1, wherein the meat-like food product has a pink to red color before cooking to indicate a raw or uncooked state."

236. Brown discloses that "[l]eghemoglobin is ... used as an indicator that the consumable is finished cooking," such as "detecting the change in color of red to brown when the product is cooked." EX1012(Brown), [00372]. In other words, Brown discloses that the uncooked, raw product is a red color because of leghemoglobin.

237. Brown also generally teaches that its "meat substitute product [has] a pink color before cooking to indicate a raw state and causes the meat substitute product to transition to a white or brown color during cooking progression." *Id.*, [00366].

13. Claim 16

238. In my opinion, Brown discloses “[t]he meat-like-food product of claim 1, wherein at least a portion of the meat-like food product, upon cooking, transitions in color from a pink to red color in a raw or uncooked state to a lighter pink to brown color in a partially cooked to fully cooked state” for the same reasons discussed above for claim 15.

14. Claims 17, 18, and 19

239. In my opinion, Brown and Giacino render obvious these limitations. These limitations recite that cooking the meat-like-food product results in the production of, respectively, five, ten, and twenty volatile compounds from a long list of volatile compounds.

240. As discussed above with respect to claim 1, Brown discloses an exemplary muscle replica that is prepared by mixing pea flour, sunflower oil, and **glucose** and then heating the mixture in the presence of leghemoglobin to provide volatile compounds that “are often associated with the aroma of cooked meat.” EX1012(Brown), [00364]. As discussed above, pea flour contains cysteine. Moreover, Giacino’s Example VI composition also contains cysteine, which is combined with Brown’s glucose.

241. A POSITA would have known that glucose and cysteine generate a number of volatile compounds upon heating. *See* EX1024(MacLeod), 384 (Table

14: “SOME VOLATILE REACTION PRODUCTS OF GLUCOSE/CYSTEINE AND OF GLUCOSE/CYSTINE”). These include the claimed compounds 2,3-butanedione, 2,3-dimethyl-pyrzine, 2,5-dimethyl-pyrazine, 2-acetylthiazole, 2-methyl-thiazole, acetaldehyde, acetic acid, benzldehyde, benzene, butanone, carbon disulfide, dihydro-3-(2H)-thiophenone, ethanol, furfural, methanethiol, methylpyrazine, propanal, p-xylene, pyrrole, thiophene, and toluene. *Id.*

242. A POSITA would have also known that ribose and cysteine generate volatile compounds upon heating. *See* EX1025(MacLeod), 385 (Table 15). These include the claimed compounds carbon disulfide, methanethiol, acetaldehyde, furfural, pyrrole, methylpyrazine, 2,5-dimethylpyrazine, 2-methylthiazole, and 2-acetylthiazole. *Id.*

243. Thus, Brown discloses these claims.

15. Claim 20

244. In my opinion, Brown and Giacino render obvious “[t]he meat-like-food product of claim 1, wherein the at least two volatile compounds are selected from 2-methyl-furan, bis(2-methyl-3-furyl)disulfide, 2-pentyl-furan, 3,3'-dithiobis-2-methyl-furan, 2,5-dimethyl-pyrazine, 2-methyl-3-furanthiol, dihydro-3-(2H)-thiophenone, 5-methyl-2-thiophenecarboxaldehyde, 3-methyl-2-thiophenecarboxaldehyde, 2-methyl-thiazole, dimethyl sulfide, decanal, 5-

ethyldihydro-2(3H)-furanone, dihydro-5-pentyl-2(3H)-furanone, 2-octanone, 3,5-octadien-2-one, p Cresol, p cresol, and hexanoic acid.”

245. As discussed above with respect to claim 1, Brown discloses an exemplary muscle replica that is prepared by mixing pea flour, sunflower oil, and **glucose** and then heating the mixture in the presence of leghemoglobin to provide volatile compounds that “are often associated with the aroma of cooked meat.” Brown, [00364]. A POSITA would understand that pea flour contains cysteine. Moreover, Giacino’s Example VI composition also contains cysteine, which is combined with Brown’s glucose.

246. A POSITA would have known that glucose and cysteine generates a number of volatile compounds upon heating. *See* EX1024(MacLeod), 372-73 (“SOME THERMAL DEGRADATION PRODUCTS OF GLUCOSE”), 384 (“SOME VOLATILE REACTION PRODUCTS OF GLUCOSE/CYSTEINE AND OF GLUCOSE/CYSTINE”). These include the compounds 2-methyl-furan and 2-methyl-thiazole. *Id.* Thus, Brown discloses this claim.

247. A POSITA would have also known that ribose and cysteine generate volatile compounds upon heating. *See* EX1025(MacLeod), 385 (Table 15). These include the claimed compounds 2,5-dimethylpyrazine and 2-methylthiazole. *Id.*

16. Claim 21

248. In my opinion, Brown and Giacino render obvious “[t]he meat-like-food product of claim 1, wherein the at least two volatile compounds are 2-methyl-furan and bis(2-methyl-3-furyl)disulfide.”

249. As discussed in Claim 20, glucose and cysteine generate the compound 2-methyl-furan.

250. A POSITA would also understand that heating Giacino’s Example VI composition, specifically the ingredients L-cysteine hydrochloride, thiamine hydrochloride, hydrolyzed vegetable protein, and water, results in the volatile compound bis(2-methyl-3-furyl)disulfide, which was known to provide an “intense roasted aroma.” EX1141(Evers), 184; EX1005 (McGorin), VII. This had been known since the 1970s.

17. Claim 22

(a) 22[pre]: A meat-like-food product produced by a method comprising:

251. To the extent the preamble is limiting, Brown discloses “[a] meat-like-food product produced by a method” for the same reasons I discussed above for limitation 1[pre].

(b) 22[a]: providing one or more plant proteins; and

252. Brown discloses “providing one or more plant proteins” for the same reasons I discussed above for limitation 1[a].

(c) 22[b]: combining, with the one or more plant proteins: a heme-containing protein

253. Brown discloses “combining, with the one or more plant proteins: a heme-containing protein.” This limitation is identical to limitation 1[b], except it lacks the percentage dry weight requirement. Thus, Brown discloses this limitation for the same reasons discussed for limitation 1[b] excluding the analysis regarding the heme-containing protein’s percentage on a dry weight basis.

(d) 22[c]: one or more of glucose, ribose, fructose, lactose, xylose, arabinose, glucose-6-phosphate, maltose, and galactose; and

254. Brown discloses “one or more of glucose, ribose, fructose, lactose, xylose, arabinose, glucose-6-phosphate, maltose, and galactose” for the same reasons I discussed above for limitation 1[c].

(e) 22[d]: one or more of cysteine, cystine, thiamine, and methionine;

255. Brown discloses, and Brown and Giacino render obvious, “one or more of cysteine, cystine, thiamine, and methionine.” This limitation is identical to limitation 1[d] except that it lacks the concentration requirement. Thus, this limitation is disclosed or rendered obvious for the same reasons I discuss above in limitation 1[d] excluding the discussion regarding concentration.

- (f) **22[e]: wherein the meat-like food product is free of animal heme-containing protein;**

256. Brown discloses “wherein the meat-like food product is free of animal heme-containing protein” for the same reasons I discussed above for limitation 1[e].

- (g) **22[f]: wherein cooking the meat-like-food-product results in the production of at least two volatile compounds which have a meat-associated aroma; and**

257. Brown discloses “wherein cooking the meat-like-food-product results in the production of at least two volatile compounds which have a meat-associated aroma” for the same reasons I discussed above for limitation 1[f].

- (h) **22[g]: wherein the meat-like food product is in a form selected from the group consisting of a hotdog, a burger, ground meat, a sausage, a steak, a filet, a roast, a meatball, a meatloaf, or bacon.**

258. Brown discloses “wherein the meat-like food product is in a form selected from the group consisting of a hotdog, a burger, ground meat, a sausage, a steak, a filet, a roast, a meatball, a meatloaf, or bacon” for the same reasons I discussed above for limitation 1[g].

18. Claim 23

259. In my opinion, Brown discloses “[t]he meat-like food product of claim 22, wherein the meat-like food product is free of animal products.” As discussed above in limitation 1[e], none of the ingredients listed in Brown’s muscle replica or Giacino’s beef flavor composition come from animals.

B. Ground 1B (Brown, Giacino, Ronai)

260. In my opinion, the combination of Brown, Giacino, and Ronai render obvious claims 2 and 3.

261. Claim 2 recites that the plant protein is a textured vegetable protein, and claim 3 further recites that the textured vegetable protein is a textured soy protein. In my opinion, Brown and Giacino combined with Ronai render obvious claims 2 and 3.

262. As discussed above, it is my opinion that claims 2 and 3 are disclosed by Brown. In the alternative, a POSITA would understand that Brown's composition (or the combined Brown-Giacino composition) could be modified and would be motivated to include well-known plant proteins, including texturized vegetable/soy proteins, to provide the same meat-like-food product using ordinary skill in the art with a reasonable expectation of success.

263. Textured vegetable proteins, including textured soy proteins, have since the 1960s been known in the art to be suitable for use in meat analog compositions. By the time of the '241 patent, commercial textured vegetable protein products were commonly used as proteins for meat-free alternatives to provide meat-like texture, flavor, taste, and mouth-feel. Ronai, a patent that was issued in 1979 and is titled "Textured Vegetable Protein Flakes," is but one of many disclosures of textured vegetable proteins.

264. Ronai teaches a “dried flaked textured high vegetable protein material which instantly hydrates and has an improved flavor.” EX1132 (Ronai), 1:37-39. Specifically, Ronai teaches “the conversion of soybeans to texturized flakes.” *Id.*, 3:23-25. Thus, Ronai discloses claim 2’s textured vegetable protein and claim 3’s textured soy protein.

265. Brown and Giacino are analogous art to the ’241 patent, as I discussed above. Ronai is as well. Ronai teaches that its textured soy protein flakes “can be used in an endless variety of ways to furnish vegetable protein as a meat protein substitute,” such as “to produce products which simulate fish, poultry ..., beef, veal, liver, mutton and ham.” EX1132(Ronai), 8:55-68. This is the same field of endeavor as the ’241 patent, Brown, and Giacino, which all discuss non-meat compositions that simulate meat flavors.

266. A POSITA would have been motivated to use Ronai’s textured soy protein as the “isolated, purified proteins,” including isolated soy proteins, in Brown alone or the Brown-Giacino composition to simulate the texture of real meat. EX, [00299]. Indeed, Brown does not disclose any particular form that the isolated proteins must take, and a textured soy protein was a well-known form of an isolated protein. EX1132(Ronai), 12:31 (“The flakes were very high in protein content.”); 10:26 (53.5% protein on a dry weight basis). Ronai teaches the well-known benefits of textured soy proteins, including that such proteins produce “a less beany flavor,”

and are “easy to cook,” “dry, storable, light-tan-colored, palatable and appetizing in appearance,” “do not impart any unwanted taste to the final food product,” “have a consistency and cohesiveness,” “an improved texture without the need of texturizing agents,” and “provide a stable, lasting base to which color, flavor, nutrients and the like can be added.” EX1132(Ronai), 2:14-57. In other words, Ronai teaches a particularly beneficial protein product for use in meat alternative food products, and a POSITA would have been motivated by such benefits.

267. Indeed, a POSITA would have understood that Brown alone or Brown-Giacino combination could readily be modified to enhance the texture of the composition using Ronai’s textured soy proteins. Indeed, Giacino analogously teaches that “[v]arious other materials and ingredients can be incorporated into the compositions.” EX1015(Giacino), 2:38-41.

268. A POSITA would have a reasonable expectation of success combining Brown and Giacino with Ronai. In particular, Brown already discloses adding an isolated protein component into its meat substitute, and as discussed above, Ronai’s textured soy protein is an example of an isolated protein component. Moreover, Ronai teaches that its textured soy protein flakes “can be used in an endless variety of ways to furnish vegetable protein as a meat protein substitute,” such as “to produce products which simulate fish, poultry ..., beef, veal, liver, mutton and ham.” EX1132(Ronai), 8:55-68. Thus, a POSITA would have reasonably expected adding

Ronai's textured soy protein flakes to Brown's meat substitute and Giacino's meat-flavoring composition to succeed in creating a meat replica with improved texture and flavor.

C. Ground 1C (Brown, Giacino, Rolan)

269. In my opinion, Brown and Giacino in further view of Rolan render obvious claims 10 and 11.

270. Claim 10 recites “[t]he meat-like-food product of claim 1, further comprising combining, with the one or more plant proteins, one or more of inosine, inosine monophosphate (IMP), guanosine, guanosine monophosphate (GMP), and adenosine monophosphate (AMP).”

271. Claim 11 recites “[t]he meat-like-food product of claim 1, further comprising combining with the one more plant proteins, one or more of beta-carotene, alpha-tocopherol, caffeic acid, propyl gallate, and epigallocatechin gallate.”

272. Rolan discloses the limitation in claim 10. Specifically, Rolan teaches that a “meat analog composition” wherein “a variety of additional ingredients may be added.” EX1021(Rolan), [0006], [0017], [0038]. Such ingredients include various flavoring agents such as “inosinic acid salts.” *Id.*, [0096]. A POSITA would understand that inosinic acid salt is an inosine monophosphate as recited in challenged claim 10. EX1104(PubChem, Inosinic acid).

273. Rolan also discloses the limitation in claim 11. Rolan teaches that other ingredients that may be added include “antioxidants” like “beta-carotene,” “caffeic acid,” and “tocopherols,” each of which is recited in claim 11. EX1021(Rolan), [0038], [0095].

274. A POSITA would have found it obvious to combine Brown (with or without Giacino) with these teachings in Rolan. A POSITA would understand that Brown’ or the Brown and Giacino combination could be modified and would be motivated to include other well-known flavoring and antioxidant agents to enhance and preserve the composition’s beef flavor/aroma using ordinary skill in the art with a reasonable expectation of success.

275. First, like Brown and Giacino, Rolan is analogous art to the ’241 patent. Specifically, Rolan is directed to meat analog compositions that simulate meat flavor/aroma in non-animal food compositions. EX1021(Rolan), [0006], [0017].

276. A POSITA would be motivated to make this combination. Brown itself invites a POSITA to modify its composition by adding various ingredients that can provide the “[c]haracteristic flavor and fragrance components...similar[] to meat.” EX1012(Brown), [00361], [00295]. In view of that, a POSITA would turn to Rolan, which teaches “meat analog compositions” that “have improved nutritional properties, such as reduced fat and cholesterol, without sacrificing flavor, texture, mouth feel, and aroma of ground meat” without real animal meat. EX1021(Rolan),

[0006], [0017]. In particular, Rolan teaches that “a variety of additional ingredients may be added” to its meat analog compositions. EX1021(Rolan), [0006], [0017], [0038].

277. The “additional ingredients” that could be added to compositions, as taught by Rolan, include the antioxidants discussed above. Rolan notes that these antioxidants prevent the oxidation of fatty acids and oxidative color changes in its compositions, and that antioxidants may be natural or synthetic. EX1021(Rolan), [0038]. Moreover, like Giacino, Rolan also teaches that its flavoring agents, including inosinic acid, “may mimic or replace constituents found in lean meat or fat tissues...[to] provide an animal meat flavor, a grilled meat flavor, a rare beef flavor,” and such agents “may be natural...[or] artificial. ” EX1021(Rolan), [0096].

278. Based on the above teachings, a POSITA would have been motivated to add Rolan’s antioxidant (including the claimed beta-carotene) and flavoring agents (including the claimed inosine monophosphate) to further enhance and preserve the Brown and the Brown and Giacino compositions’ beef flavor/aroma. A POSITA would know that this combination is the application of a known technique to a known product ready for improvement, yielding the predictable result of enhanced and preserved meat flavor.

279. A POSITA also would have a reasonable expectation of success making this combination. Rolan provides specific antioxidant concentrations and flavoring

agents that may be added to its compositions using ordinary skill, *i.e.*, mixing. EX1021(Rolan), [0095], [0096], [123]. A POSITA would reasonably expect that combining Rolan's antioxidants and flavoring agents with Brown and the Brown and Giacino combination would enhance and preserve the beef flavor/aroma of the composition. Accordingly, adding an antioxidant (such as "beta-carotene," "caffeic acid," or "tocopherols") and flavoring agent (such as inosinic acid salts, *i.e.*, inosine monophosphate) to the Brown and Brown-Giacino compositions results in a modified composition that satisfies the limitations of challenged claims 10 and 11.

XII. GROUNDS 2A-2D: ROVAART, CONRAD, CRANE, RONAI, GIACINO, ROLAN

280. As I explain below, Rovaart in view of Conrad, and further in view of Crane render obvious claims 1, 4-6, 8, 10, 13, and 15-23 (Ground 2A). Rovaart in view of Conrad and Crane, and further in view of Ronai renders obvious claims 2-3 (Ground 2B). Rovaart in view of Conrad and Crane, and further in view of Giacino renders obvious claims 8-9 and 14 (Ground 2C). Rovaart in view of Conrad and Crane, and further in view of Rolan renders obvious claims 11-12 (Ground 2D).

A. Ground 2A (Rovaart, Conrad, Crane)

281. A POSITA would recognize that the combination of Rovaart, Conrad, and Crane renders claims 1, 4-6, 8, 10, 13, and 15-23 obvious. In particular, Rovaart alone discloses or renders obvious limitations 1[pre]/22[pre], 1[a]/22[a], 1[c]/22[c], 1[d]/22[d], 1[f]/22[f], 1[g]/22[g]. As for limitations 1[b]/22[b], Rovaart and Conrad

in view of Crane teaches adding a heme-containing protein to the plant proteins. Moreover, a POSITA would be motivated to combine the teachings of this references to arrive at the claimed inventions (and have a reasonable expectation of success at doing so) for the various reasons explained below.

2. 1[pre]: A meat-like-food product produced by a method comprising:

282. To the extent the preamble is limiting, Rovaart, Conrad, and Crane render obvious “[a] meat-like-food product produced by a method.”

283. Rovaart teaches that, “[t]he present invention is concerned with the preparation of porous expanded food products having meat-like taste.” EX1125(Rovaart), 1:6-7. It discloses that the process “yields a product with a meat-like texture and the flavour of boiled beef.” EX1125(Rovaart), 6:26-27.

3. 1[a]: providing one or more plant proteins

284. In my opinion, Rovaart, Conrad, and Crane render obvious “providing one or more plant proteins.”

285. Rovaart discloses that its products comprise one or more plant proteins. Its products can be prepared from “substances rich in protein of plant...origin.” EX1125(Rovaart), 1:5-13. Rovaart’s “process comprises forming a mixture comprising [] 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(Rovaart), 1:42-44, 56-62. Certain Rovaart examples utilize soybean flour.

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(Rovaart), 3:33-35, 5:23-24, 6:21-23. A POSITA would understand that a plant substance rich in protein is a plant protein and that soya bean flour is a plant protein.

4. 1[b]: combining, with the one or more plant proteins: a composition comprising a heme-containing protein, wherein the composition comprises at least 60% of the heme-containing protein on a dry weight basis

286. In my opinion, Rovaart, Conrad, and Crane render obvious “a composition comprising a heme-containing protein, wherein the composition comprises at least 60% of the heme-containing protein on a dry weight basis.”

287. Crane teaches a recombinant heme-containing protein which are “completely functional” and suitable for “commercial applications.” EX1014(Crane), Abstract, [0021], [0024]; *see also* EX1007(Batt), ¶¶31-32. Crane teaches producing various heme-proteins. EX1014(Crane), [0021] (“The ... heme-binding proteins ... encompassed by the methods ... include ... e.g... hemoglobin, myoglobin ... leghemoglobin ...”). Thus, Crane discloses a heme-containing protein.

288. The term “comprises at least 60% of the heme-containing protein on a dry weight basis” does not have patentable weight. *See supra*, Section X.C. Hence,

the prior art composition only needs to contain heme-containing protein to satisfy the claim limitation.

289. However, to the extent the limitation is given patentable weight, Crane teaches that these recombinant protein expression systems produce heme-containing proteins that “were purified to >95% purity.” EX1014(Crane), [0075]; EX1007 (Batt), ¶¶28, 32; EX1014(Crane), [0060]-[0062] (“The purified preparation of recombinant heme-binding protein of the present invention has full heme incorporation and does not contain metal-free porphyrin. The purity of the preparation is assessed by the presence or absence of un-metallated heme, which can be measured by fluorescence spectroscopy and resonance Raman spectroscopy.”). A POSITA would understand that 95% purity refers to the dry weight basis of the recombinant hemoglobin.

290. In addition, Conrad discloses that for “the hemoglobin part separated off from blood, the protein content of which is about **90% by weight.**” EX1013(Conrad), 4:3-17. As I explain below, this is referring to 90% by dry weight. Conrad teaches that this amount of hemoglobin achieves desirable flavors and coloring. Although Conrad is referring to hemoglobin derived from meat sources, as I also explain below, it would have been obvious to replace Conrad’s hemoglobin with Crane’s recombinant hemoglobin, which comes from a non-animal source under Petitioner’s theory of infringement.

291. Thus, the combination of Rovaart, Conrad, and Crane renders obvious this limitation. For reasons explained below, a POSITA would have been motivated to make this combination and would have had a reasonable expectation success in doing so.

(a) Rovaart, Conrad, and Crane Are Analogous Art to the '241 patent

292. Rovaart, Conrad and Crane are all analogous art to the '241 patent.

293. Rovaart, which is titled “In situ *production of meat like flavor in expanded porous food product*,” is analogous art to the '241 patent because describes the “the preparation of porous expanded food products having a meat-like taste.” EX1125(Rovaart), 1:5-7. 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(Rovaart), 1:5-13.

294. 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(Rovaart), 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(Rovaart), 1:38-48.

295. 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.

296. 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. Rovaart is

therefore from the same field of endeavor as the '241 patent and is reasonably pertinent to the problem facing the named inventors of the '241 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.

297. Similarly, Conrad and Crane are also directed to the same field of endeavor.

298. **Conrad**, which relates to a “Bran-Gluten Meat Replacement Product” (see title), is analogous art to the '241 patent. Conrad is in the same field of endeavor as the '241 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.

299. 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.

300. 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%

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

302. 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.

303. Conrad’s meat replacement product (“grain meat”/“wheat meat”), which maps to the claimed “meat-like-food product,” is used to partially replace real meat in consumables. EX1013, 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.

304. 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).

305. **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].

306. 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 ’241 patent.³ Based on my review of Crane, I agree with Dr. Batt that a POSITA seeking to modify a meat-like-food product (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

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.

regarding a POSITA's understanding of Crane's disclosure in my analysis in my Declaration.

(b) Motivation to Combine Rovaart, Conrad, and Crane

307. A POSITA would have been motivated to combine Rovaart, Conrad, and Crane to achieve the subject matter of the challenged claims.

308. **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(Rovaart), 1:5-7. To this end, Rovaart teaches including “*suitable flavouring agents*” in its products, “which may be natural.” EX1125(Rovaart), 1:24-29. Rovaart teaches adding sugars/sulfur-compounds for this purpose (see limitations [b], [d]).

309. 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 at a temperature below 150°C does not produce the desired flavour*” of its products. EX1125(Rovaart), 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.

310. 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(Rovaart), 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(Rovaart), 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.

311. 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(Rovaart), 1:24-29.

312. Conrad. To further enhance Rovaart's products' meaty flavor, **Conrad** teaches a POSITA that adding heme-protein 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.

313. 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.

314. Conrad also teaches levels of heme-protein in foodstuff products that achieve these desirable meat-like properties of color and flavor.

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, 4:3-17.

315. 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.*, EX1039(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
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).

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

317. 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.

318. 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.

319. 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). EX1039(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.*

320. Crane. In addition, a POSITA would be motivated to substitute Conrad’s blood-sourced hemoglobin with Crane’s recombinantly-produced heme-proteins.

321. 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. For example, obtaining blood from slaughtered animals incurs the same environmental consequences, expenses, and other ramifications as cultivating animals for meat.

322. 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...”).

323. 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.”).

324. 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...**”).

325. 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...*”).

326. *Third*, Crane’s heme-proteins can be purified (EX1014(Crane), [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.

327. Crane teaches producing various heme-proteins. EX1014(Crane), [0021] (“The ... heme-binding proteins ... encompassed by the methods ... include ... e.g... hemoglobin, myoglobin ... leghemoglobin ...”).

328. A POSITA would be motivated to utilize Crane’s 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**.

329. 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(Garracho-Villegas), 79 (leghemoglobin is “red pigment isolated from soybean root nodules”), EX1035(Nicola); EX1033(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.

330. 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. Likewise, as Crane’s recombinant leghemoglobin (found natively in plants) is a heme-protein like Conrad’s hemoglobin, a POSITA would expect it to contribute to flavor in the same manner as hemoglobin.

331. Nutrition: As I discuss further above (Background Section VII), 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 hemoglobin, myoglobin, and leghemoglobin is “fully incorporated” with heme iron. EX1014, [0080], [0084]-[0085].

(c) Lipid Oxidation

332. I understand that Patent Owner submitted declarations during the prosecution of the ’241 patent that opined that the relationship between heme-containing proteins, such as leghemoglobin, hemoglobin and myoglobin, and lipid oxidation would discourage a POSITA from including a heme-containing protein in a meat substitute or food flavor composition because the resulting flavor and/or aroma might be undesirable. For several reasons, I disagree.

333. **First**, a POSITA would understand that heme-containing proteins such as hemoglobin and myoglobin are naturally present in conventionally obtained meat, yet cooking conventionally obtained meat, which inevitably undergoes some amount of lipid oxidation, does not produce off-flavors. Quite the contrary, many consumers associate cooked meat with a pleasant aroma. Hence, heme-containing proteins already naturally play a part in the flavor and aroma of conventionally obtained meat. See EX1005(McGorin), Sections V.C, VIII.B.

334. **Second**, although heme-containing proteins can lead to lipid oxidation *over time*, this does not teach away from a method of generating a meaty flavor and/or aroma at the time of cooking the product. A POSITA would understand that the food product is likely to be consumed shortly after cooking, before any undesirable lipid oxidation has had a chance to develop. *See id.*

335. **Third**, it was well-known in the art that oxidized lipids can contribute positively to meat flavor. *See id.*

336. **Fourth**, a POSITA would understand that potential lipid oxidation can be mitigated with the use of antioxidants. *See id.*

337. Accordingly, a POSITA would understand that, although lipid oxidation could in some cases affect the flavor of food products such as heme-containing meat or meat flavorings, it would be inaccurate and an oversimplification to say that there is an expectation that lipid oxidation would negatively, or in all instances, affect the flavor of such products.

(d) Reasonable Expectation of Success

338. A POSITA would have a reasonable expectation of success in combining the teachings of Rovaart, Conrad, and Crane.

339. First, only ordinary skill would have been required to prepare and combine the compositions taught in these references into a meat-like-food product. Rovaart already discloses various formulations, including amounts of its precursors,

for its food products. EX1125(Rovaart), 3:33-39. Only ordinary skill would have been required to add recombinant hemoglobin (*e.g.*, hemoglobin, leghemoglobin) to the food products in amounts taught by Conrad. *See, e.g.*, EX1013(Conrad), 1:56-61 (up to 10% hemoglobin, and preferably 4-6% by dry weight), 4:32-40 (adding 100g hemoglobin to a product having a total weight of 2100g, *i.e.*, 4.8% hemoglobin by dry weight). For example, only ordinary skill would have been required to mix in the recombinant hemoglobin with the Rovaart food products' other ingredients (*e.g.*, protein, ribose, cysteine, sodium chloride, calcium chloride) before transferring the mixture to a feed hopper of an extruder for preconditioning and heating (as taught by Rolan). *See, e.g.*, EX1125(Rovaart), 3:38-62.

340. Second, as I explain elsewhere in my declaration, the chemistry of the Maillard reaction was long known, including the identity of specific precursor compounds that, when reacted with heat, would produce a meaty flavor and aroma. *See supra*, Section VII.D; EX1005(McGorin), Sections V.B, V.D.

341. Third, as Dr. Batt explains, Crane taught a POSITA how to manufacture a variety of heme-containing proteins, including proteins native to animals, plants, and other species, using recombinant technology. EX1007(Batt), ¶¶31-32. As expressly taught in Crane, such heme-containing proteins could be isolated for use in a variety of applications. *Id.*; EX1014(Crane), [0024], [0060]-[0062], [0075]. Hence, as Dr. Batt opines, a POSITA would have been able to use the teachings of

Crane to successfully express recombinant heme-containing proteins from expression systems for use in the meat analog compositions of Rolan. *See* EX1007(Batt), ¶¶49-53.

- 5. 1[c]: a compound selected from glucose, ribose, fructose, lactose, xylose, arabinose, glucose-6-phosphate, maltose, and galactose, and mixtures of two or more thereof; and**

342. In my opinion, Rovaart, Conrad, and Crane render obvious this limitation.

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

344. 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(Rovaart), 1:38-46.

345. Rovaart's examples disclose specific combinations of these sugar compounds with sulfur compounds (*see* Limitations 1[d] and 22[d] *infra*). E.g., 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(Rovaart), 3:32-37, 5:10-16, 5:38-40, 6:17-20.

6. 1[d]: a compound selected from cysteine, cystine, thiamine, methionine, and mixtures of two or more thereof in a concentration of at least 1.5 mM;

346. In my opinion, Rovaart, Conrad, and Crane render obvious this limitation.

347. Rovaart teaches including the claimed sulfur compounds in its products in order to achieve meat-like aromas. As a POSITA would recognize, these sulfur compounds are Maillard reaction precursors long known to produce volatile compounds associated with meaty aromas when heated. *See* limitation [d] *infra*.

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

349. Rovaart’s examples disclose specific combinations of these sulfur compounds and sugar compounds (*see* Limitation 1[c] *supra*). E.g., 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(Rovaart), 3:32-37, 5:10-16, 5:38-40, 6:17-20.

350. As I opined above, the limitation “in a concentration of at least 1.5 mM” should not be given any patentable weight. *See, supra*, Section X.C.

351. However, to the extent the limitation is given patentable weight, Rovaart discloses in Example 1 that 66.7 g L-cysteine is part of a 3250 gram “aqueous solution.” EX1125(Rovaart), 3:35-37. As I discussed above, when measuring concentration of a solute in a solution, a POSITA would typically only consider the solute alone and the solvent (in this case, water). Subtracting all of the ingredients besides water and cysteine results in about 2967 grams of solution, which is about 2.96 liters in volume. 66.7 grams of cysteine is 550.5 millimoles, which results in a concentration of about 186 mM. If one were to consider the entire volume of the “aqueous solution,” which is about 3.2 liters, that results in a cysteine concentration of approximately 172 mM. In either case, both amounts exceed the claimed 1.5 mM.

7. 1[e]: wherein the meat-like food product is free of animal heme-containing protein;

352. In my opinion, Rovaart, Conrad, and Crane render obvious this limitation.

353. Rovaart notes that it is directed to “the preparation of porous expanded food products having a *meat-like taste*” that “*simulat[e]* the texture of meat.”

EX1125(Rovaart), 1:5-10. A POSITA would therefore understand that Rovaart's food products lack animal meat and therefore lack animal heme-containing protein.

354. The exemplary embodiments disclosed in Rovaart also list ingredients that lack animal proteins. For example, Example 1 lists soya bean flour, ribose, cysteine, sodium chloride, and calcium chloride, none of which contain any animal protein. EX1125(Rovaart), 3:33-37.

355. Moreover, adding recombinant hemoglobin (*e.g.*, bovine hemoglobin or plant/soy leghemoglobin) to Rovaart's food products would continue to satisfy this limitation. First, leghemoglobin is an oxygen-carrying phytoalbumin found in the nitrogen-fixing root nodules of leguminous plants, such as soy, and is thus not an animal product. *See* EX1073(Santana), 1259 (discussing how leghemoglobin present in the root nodules of leguminous plants facilitates oxygen diffusion to bacteroids responsible for expressing nitrogenase). Second, as I explained above, a POSITA would be motivated to combine Conrad with Rovaart to further enhance Rovaart's products' meaty flavor by adding heme-protein, and a POSITA would be further motivated to substitute Conrad's blood-sourced hemoglobin with Crane's recombinantly-produced heme-proteins including recombinant hemoglobin, myoglobin or leghemoglobin (*i.e.*, a non-animal heme-containing protein). Patent Owner has taken the position in the parallel district court action that such proteins manufactured using recombinant techniques are not "animal products," even if the

protein is natively found in animals, such as bovine myoglobin and hemoglobin. *See supra*, Section X.A; EX1116(SAC), ¶32.

8. 1[f]: wherein cooking the meat-like-food-product results in the production of at least two volatile compounds which have a meat-associated aroma; and

356. In my opinion, Rovaart, Conrad, and Crane render obvious this limitation.

357. Rovaart teaches cooking its meat replica products. Rovaart's process comprises "heating the mixture to a temperature of at least 150°C" under pressures "sufficient to produce a meat flavour in the interior of the final product." EX1125(Rovaart), 1:38-48, 2:63-68.

358. That heating Rovaart's food product produces a meaty flavor (and hence meaty flavor/aroma) is not surprising because Rovaart's food product includes well-known flavor precursors, including cysteine, glucose, and ribose. A POSITA would understand that heating a reaction mixture that includes amino acids and sulfur compounds, such as cysteine, in the presence of reducing sugars, such as ribose and glucose, would induce different reactions including, among other things, a Maillard reaction. *See supra*, VII.D; EX1005(McGorin), Sections V.B, V.D; EX1017(Mottram), 417 ("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.”); EX1026(Dwivedi), 501, (“[C]ysteine, on heating produces a number of sulfur compounds that contribute significantly in meat like synthetic flavor formulations.”); EX1024(MacLeod), 399-407 (“a large number of ‘reaction product’ patents [were] granted,” in which meat flavor precursors, such as cysteine, thiamine, methionine, glucose, ribose, and vegetable protein hydrolysates, among others, react with each other to produce meaty aromas and flavors). As explained below, a POSITA would have understood that these reactions, including the Maillard reaction, would produce at least two volatile compounds having a meat-associated flavors/aroma.

359. For example, it was well-known in the art that heating ribose and cysteine induces reactions that produce a number of volatile compounds that have been associated with a meaty aroma. *Compare* EX1024(MacLeod), 384 (Table 14: identifying a list of volatiles produced by reacting cysteine and glucose), 385 (Table 15: identify a list of volatiles produced by reacting cysteine and ribose) *with id.*, 313-356 (Table 1: identifying volatile compounds “of Natural Beef Aroma,” including the many of the volatiles found in Tables 14 and 15).

360. A POSITA would have understood that adding recombinant hemoglobin (*e.g.*, recombinant bovine hemoglobin or plant leghemoglobin) to Rovaart’s food product would only further contribute to the meaty aroma and volatiles produced Conrad expressly discloses that hemoglobin “improves [] meat

flavour.” Notwithstanding the beneficial contributions of the heme-containing protein, however, a POSITA would have understood that at the very least the reactions between a sulfur compound (cysteine) and reducing sugars (ribose, glucose) present in Rovaart’s food product would have produced at least two volatile compounds having a meaty aroma.

361. 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.” EX1012, 5:10-36. A similar “boiled beef” flavor is produced when the same process is performed, substituting glucose for xylose. EX1012, 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.” EX1012, 5:38-49.

- 9. 1[g]: wherein the meat-like food product is in a form selected from the group consisting of a hotdog, a burger, ground meat, a sausage, a steak, a filet, a roast, a meatball, a meatloaf, or bacon.**

362. In my opinion, Rovaart, Conrad and Crane render obvious this limitation.

363. Rovaart teaches meat-like-food product that is the texture and taste of various forms of meat. Rovaart’s process results in a “final product [that] has a fibrous structure analogous to the texture of meat and a meat-flavour.” EX1125, 1:38-48, 2:63-68. For example, Rovaart’s Example 1 discloses that when the dough

exits the die, it “forms[s] a continuous cylinder of fibrous expanded material” with “a flavour analogous to that of roast chicken meat.” EX1125(Rovaart), 3:58-62. Example 2 discloses “a product having the flavour of boiled beef and a meat-like texture” with a consistency that “is firmer than that of the product obtained in Example 1.” EX1125(Rovaart), 5:32-34. Example 3 discloses “[a] crisp, expanded porous product” with flavor “similar to that of roast beef” and a product that is “ground.” EX1125(Rovaart), 5:47-49, 62-65. Examples 4 and 5 disclose “a product with a meat-like texture and the flavour of boiled beef.” EX1125(Rovaart), 6:23-28, 48-52. A POSITA would therefore understand from these disclosures that Rovaart’s food product has the form of ground meat.

364. It also would have been obvious to mold Rovaart’s products into any one of the forms recited in the claims as a matter of routine experimentation. A POSITA further would have been motivated to mold Rovaart’s products into obvious forms such as a hotdog, burger patty, ground meat or the like. Indeed, a POSITA would understand and be motivated to create these forms because they are forms consumers typically associate with meat, and they would have a reasonable expectation of success in creating these forms using ordinary skill, *i.e.*, simple manipulation of Rovaart’s porous expanded food products.

10. Claim 4

365. In my opinion, Rovaart, Conrad and Crane render obvious “[t]he meat-like-food product of claim 1, wherein the composition comprising the heme-containing protein comprises at least 70% of the heme-containing protein on a dry weight basis.”

366. As I discuss above, the term “composition...comprises at least 70% of the heme-containing protein on a dry weight basis” does not have patentable weight. *See supra*, Section X.B. Hence, the prior art composition only needs to contain heme-containing protein to satisfy the claim limitation.

367. To the extent that limitation is given patentable weight, it is my opinion that Rovaart in view of Conrad and further in view of Crane discloses “[t]he meat-like-food product of claim 1, wherein the composition comprising the heme-containing protein comprises at least 70% of the heme-containing protein on a dry weight basis” for the same reasons discussed above for limitation 1[b].

11. Claim 5

368. In my opinion, Rovaart, Conrad and Crane render obvious “[t]he meat-like-food product of claim 1, wherein the composition comprising the heme-containing protein comprises at least 80% of the heme-containing protein on a dry weight basis.”

369. As I discuss above, the term “composition...comprises at least 80% of the heme-containing protein on a dry weight basis” does not have patentable weight. *See supra*, Section X.B. Hence, the prior art composition only needs to contain heme-containing protein to satisfy the claim limitation.

370. To the extent those terms are given patentable weight, it is my opinion that Rovaart in view of Conrad and further in view of Crane discloses “[t]he meat-like-food product of claim 1, wherein the composition comprising the heme-containing protein comprises at least 80% of the heme-containing protein on a dry weight basis” for the same reasons discussed above for limitation 1[b].

12. Claim 6

371. In my opinion, Rovaart, Conrad, and Crane render obvious “[t]he meat-like-food product of claim 1, wherein the heme-containing protein is a globin.”

372. Rovaart in view of Conrad and Crane discloses a composition with a heme-containing protein, and Crane discloses that the heme-containing protein is a globin. EX1014(Crane), [0021] (“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)[.]”).

13. Claim 8

373. In my opinion, Rovaart, Conrad, and Crane render obvious “[t]he meat-like-food product of claim 1, wherein the cysteine is added to a concentration of about 0.8 mM to about 10 mM.” As I explained above, this limitation from claim 8 should not be given patentable weight, and therefore a prior art compound that contains cysteine meets this limitation. Thus Rovaart in view of Conrad and Crane discloses claim 8 for the same reasons it discloses claim 1.

374. It also would be obvious to a POSITA and they would be motivated to modify Rovaart’s cysteine concentration to achieve a desired beef flavor/aroma using ordinary skill with a reasonable expectation of success. Indeed, it would have simply been a matter of “routine experimentation.”

14. Claim 10

375. In my opinion, Rovaart, Conrad and Crane render obvious “[t]he meat-like-food product of claim 1, further comprising combining, with the one or more plant proteins, one or more of inosine, inosine monophosphate (IMP), guanosine, guanosine monophosphate (GMP), and adenosine monophosphate (AMP).”

376. Rovaart discloses that “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.” EX1125(Rovaart), 2:18-21. It would have been readily apparent and obvious to a POSITA to add

flavoring agents such as inosine, monophosphate, or lactic acid to Example 1 for additional flavoring as well. EX1125(Rovaart), 2:17-22.

15. Claim 13

377. In my opinion, Rovaart, Conrad and Crane render obvious “[t]he meat-like-food product of claim 1, further comprising combining with the one more plant proteins, one or more of acetic acid, lactic acid, glycolic acid, citric acid, succinic acid, tartaric acid, caprylic acid, capric acid, lauric acid, myristic acid, palmitic acid, palmitoleic acid, stearic acid, oleic acid, linoleic acid, alpha linolenic acid, gamma linolenic acid, arachidic acid, arachidonic acid, behenic acid, and erucic acid.”

378. Rovaart discloses that “flavouring and/or texturing agents such as...lactic acid...may also be added to the mixture.” EX1125(Rovaart), 2:18-21. It would have been readily apparent and obvious to a POSITA to add flavoring agents such as inosine, monophosphate, or lactic acid to Example 1 for additional flavoring as well. EX1125(Rovaart), 2:17-22.

16. Claim 14

379. In my opinion, Rovaart, Conrad and Crane render obvious “[t]he meat-like-food product of claim 1, wherein cooking comprises heating the meat-like food product at 150° C. for about 3 to about 5 minutes.”

380. Rovaart teaches that “heating [the mixture] at a temperature below 150° C does not produce the desired flavour and texture,” which a POSITA would

understand to mean that heating at a temperature of 150° C will, in fact, produce the desired meat flavor and texture. EX1125(Rovaart), 2:49-51. Rovaart also notes that the mixture can be “heated at a temperature of ... 160° ... C under a pressure of the order of 5 to 150 atmospheres” for “10 to 30 seconds.” EX1125(Rovaart), 2:63-65. Because products cook faster when cooked under pressure (and cook significantly faster under the extremely high pressure of 150 atmospheres—a pressure cooker, for example, is typically 2 atmospheres and reduces cooking times by 50-75%), a POSITA would understand from this disclosure that reducing the temperature by a slight amount to 150° C and increasing the cooking duration to 3-5 minutes would still result in the production of flavors, *i.e.* volatile compounds. *See, e.g.*, EX1015(Giacino), 6:26-31.

381. Notwithstanding the above, a POSITA would understand that claim 14 is also obvious over Rovaart, because the duration of 3-5 minutes is readily achievable via routine experimentation, as it was well within the skill of a POSITA to alter the duration of the temperature and cooking time. Rovaart teaches heating the product at a “temperature of ... 160° ... C under a pressure of the order of 5 to 150 atmospheres” for “10 to 30 seconds.” EX1125(Rovaart), 2:63-65. A POSITA would readily understand based on their experience and knowledge that heating the Maillard reaction is achieved by heating at a slightly lower temperature for 3-5 minutes. Indeed, the '241 patent places no importance on the duration of the cooking

time, merely stating that its replica patties were cooked for 3 or 5 minutes without any discussion of what importance that particular temperature or particular duration had on the release of reactions, and how it may have differed from other temperatures or durations. *See, e.g.*, EX1001('241 patent), 21:19, 22:18, 23:22-23, 23:27, 25:4, 25:36-37, 26:6, 26:38, 27:8-9, 28:42-43, 37:49, 41:33.

17. Claims 15 and 16

382. In my opinion, Rovaart, Conrad and Crane render obvious “[t]he meat-like-food product of claim 1, wherein the meat-like food product has a pink to red color before cooking to indicate a raw or uncooked state.” They also render obvious “[t]he meat-like-food product of claim 1, wherein at least a portion of the meat-like food product, upon cooking, transitions in color from a pink to red color in a raw or uncooked state to a lighter pink to brown color in a partially cooked to fully cooked state.”

383. Rovaart discloses that, after cooking the mixture, a product is obtained that is “brown in colour” and has “a meat-like texture and a boiled beef taste....” EX1125(Rovaart), 6:48-50. It would be obvious to a POSITA to start with a pink or red color imparted by the heme-containing protein prior to being cooked to simulate real meat and heating will turn the final meat-like product brown after being cooked.

384. 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).) 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 (both before and after cooking) in Conrad's grain meat as myoglobin/hemoglobin achieves in meat.

18. Claims 17, 18, and 19

385. In my opinion, Rovaart, Conrad and Crane render obvious these limitations. These limitations recite that cooking the meat-like-food product results in the production of, respectively, five, ten, and twenty volatile compounds from a long list of volatile compounds.

386. As discussed above, Rovaart teaches that its food products contain "at least one pentose or hexose," which "may be D-ribose, D-xylose, L-arabinose or glucose," and "at least one sulphur, containing amino-acid," which is preferably "[c]ysteine." EX1125(Rovaart), 1:44-46, 1:66-68. Rovaart's Example 1 uses ribose and cysteine, but a POSITA would have understood from Rovaart's teachings that glucose could also be used.

387. A POSITA would have known that ribose and cysteine generates a number of volatile compounds upon heating. *See* EX1024(MacLeod), 385 ("SOME

VOLATILE REACTION PRODUCTS OF CYSTEINE/CYSTINE-RIBOSE”).

These include the claimed compounds carbon disulfide, methanethiol, acetaldehyde, furfural, pyrrole, methylpyrazine, 2,5-dimethylpyrazine, 2-methylthiazole, and 2-acetylthiazole. *Id.* Thus, Rovaart discloses these claims.

388. A POSITA would also have known that glucose and cysteine generates a number of volatile compounds upon heating. *See* EX1024 (MacLeod), 384 (“SOME VOLATILE REACTION PRODUCTS OF GLUCOSE/CYSTEINE AND OF GLUCOSE/CYSTINE”). These include the claimed compounds 2,3-butanedione, 2,3-dimethyl-pyrzine, 2,5-dimethyl-pyrazine, 2-acetylthiazole, 2-methyl-thiazole, acetaldehyde, acetic acid, benzldehyde, benzene, butanone, carbon disulfide, dihydro-3-(2H)-thiophenone, ethanol, furfural, methanethiol, methylpyrazine, propanal, p-xylene, pyrrole, thiophene, and toluene. *Id.* Thus, Rolan discloses these claims.

19. Claim 20

389. In my opinion, Rovaart, Conrad, and Crane render obvious “[t]he meat-like-food product of claim 1, wherein the at least two volatile compounds are selected from 2-methyl-furan, bis(2-methyl-3-furyl)disulfide, 2-pentyl-furan, 3,3'-dithiobis-2-methyl-furan, 2,5-dimethyl-pyrazine, 2-methyl-3-furanthiol, dihydro-3-(2H)-thiophenone, 5-methyl-2-thiophenecarboxaldehyde, 3-methyl-2-thiophenecarboxaldehyde, 2-methyl-thiazole, dimethyl sulfide, decanal, 5-

ethyl-dihydro-2(3H)-furanone, dihydro-5-pentyl-2(3H)-furanone, 2-octanone, 3,5-octadien-2-one, p Cresol, p cresol, and hexanoic acid.”

390. As discussed above, Rovaart teaches that its food products contain “at least one pentose or hexose,” which “may be D-ribose, D-xylose, L-arabinose or glucose,” and “at least one sulphur, containing amino-acid,” which is preferably “[c]ysteine.” EX1125(Rovaart), 1:44-46, 1:66-68. Rovaart’s Example 1 uses ribose and cysteine, but a POSITA would have understood from Rovaart’s teachings that glucose could also be used.

391. A POSITA would have known that glucose and cysteine generates a number of volatile compounds upon heating.⁴ See EX1024(MacLeod), 372-73 (“SOME THERMAL DEGRADATION PRODUCTS OF GLUCOSE”), 384 (“SOME VOLATILE REACTION PRODUCTS OF GLUCOSE/CYSTEINE AND OF GLUCOSE/CYSTINE”). These include the compounds 2-methyl-furan and 2-methyl-thiazole. *Id.* Thus, Brown discloses this claim.

392. A POSITA would have also known that ribose and cysteine generate volatile compounds upon heating. See EX1025(MacLeod), 385 (Table 15). These include the claimed compounds 2,5-dimethylpyrazine and 2-methylthiazole. *Id.*

⁴ A POSITA would have also known that the generation of these volatile compounds upon heating of glucose and cysteine is inherent.

20. Claim 21

393. In my opinion, Rovaart, Conrad and Crane render obvious “[t]he meat-like-food product of claim 1, wherein the at least two volatile compounds are 2-methyl-furan and bis(2-methyl-3-furyl)disulfide.”

394. As discussed in Claim 20, a POSITA would understand that heating Rovaart’s composition, which contains glucose and cysteine, would generate the compound 2-methyl-furan.

395. Rolan also discloses that its meat analog composition can also contain ribose. EX1021, [0036]. A POSITA would understand that heating cysteine and ribose would result in the volatile compound bis(2-methyl-3-furyl)disulfide, also called “MFT-MFT.” EX1005 (McGorin), ¶¶48-53; EX1045, Abstract.

21. 22[pre]: A meat-like-food product produced by a method comprising:

396. To the extent the preamble is limiting, Rovaart discloses “[a] meat-like-food product produced by a method” for the same reasons I discussed above for limitation 1[pre].

22. 22[a]: providing one or more plant proteins; and

397. Rovaart discloses “providing one or more plant proteins” for the same reasons I discussed above for limitation 1[a].

23. 22[b]: combining, with the one or more plant proteins: a heme-containing protein

398. Rovaart in view of Conrad and further in view of Crane discloses “combining, with the one or more plant proteins: a heme-containing protein” for the same reasons I discussed above for limitation 1[b].

24. 22[c]: one or more of glucose, ribose, fructose, lactose, xylose, arabinose, glucose-6-phosphate, maltose, and galactose; and

399. Rovaart discloses “one or more of glucose, ribose, fructose, lactose, xylose, arabinose, glucose-6-phosphate, maltose, and galactose” for the same reasons I discussed above for limitation 1[c].

25. 22[d]: one or more of cysteine, cystine, thiamine, and methionine;

400. Rovaart discloses “one or more of cysteine, cystine, thiamine, and methionine” for the same reasons I discussed above for limitation 1[d].

26. 22[e]: wherein the meat-like food product is free of animal heme-containing protein;

401. Rovaart in view of Conrad and further in view of Crane discloses “wherein the meat-like food product is free of animal heme-containing protein” for the same reasons I discussed above for limitation 1[e].

- 27. 22[f]: wherein cooking the meat-like-food-product results in the production of at least two volatile compounds which have a meat-associated aroma; and**

402. Rovaart discloses “wherein cooking the meat-like-food-product results in the production of at least two volatile compounds which have a meat-associated aroma” for the same reasons I discussed above for limitation 1[f].

- 28. 22[g]: wherein the meat-like food product is in a form selected from the group consisting of a hotdog, a burger, ground meat, a sausage, a steak, a filet, a roast, a meatball, a meatloaf, or bacon.**

403. Rovaart discloses “wherein the meat-like food product is in a form selected from the group consisting of a hotdog, a burger, ground meat, a sausage, a steak, a filet, a roast, a meatball, a meatloaf, or bacon” for the same reasons I discussed above for limitation 1[g].

29. Claim 23

404. In my opinion, Rovaart in view of Conrad and further in view of Crane discloses “[t]he meat-like food product of claim 22, wherein the meat-like food product is free of animal products.”

405. As discussed above, Crane’s recombinant hemoglobin, myoglobin, and leghemoglobin is not an “animal heme-containing protein” under the Patent Owner’s infringement theory (indeed, leghemoglobin is sourced from plants). The ingredients listed in Rovaart’s Example 1 are also known not to be from animal sources. EX1125(Rovaart).

B. Ground 2B: Rovaart, Conrad, Crane, Ronai

406. As discussed in Ground 1B, Ronai discloses claims 2-3's textured soy product. Thus, the combination of Rovaart, Conrad, and Crane with Ronai would have rendered obvious claims 2-3.

407. It would have been obvious to combine Ronai with Rovaart, Conrad, and Crane. As discussed above, all of these references are analogous art to the '241 patent. Rovaart teaches that its composition use "material rich in protein," such as "soy flour." EX1125(Rovaart), 1:59-61. A POSITA would have been motivated to use Ronai's texture soy protein in place of Rovaart's soy flour, especially since textured soy protein can be made from soy flour. Ronai teaches the benefits of using textured soy protein, including "a less beany flavp;[pwqor," "easy to cook," "dry, storable, light-tan-colored, palatable and appetizing in appearance," "do not impart any unwanted taste to the final food product," "have a consistency and cohesiveness," "an improved texture without the need of texturizing agents," and "provide a stable, lasting base to which color, flavor, nutrients and the like can be added," all of which provide motivation to use Ronai's textured product. EX1032(Ronai), 2:14-57.

408. A POSITA would have a reasonable expectation of success combining Rovaart with Ronai. Rovaart using a "substance rich in protein," such as soy flour, and Ronai's textured soy protein is a concentrated protein. EX1125(Rovaart), 3:13;

EX1032(Ronai), Abstract; 3:38-41. Moreover, Ronai teaches that its textured soy protein flakes “can be used in an endless variety of ways to furnish vegetable protein as a meat protein substitute.” EX1032(Ronai), 8:55-68. A POSITA would have reasonably expected success adding Ronai’s textured soy protein flakes to Rovaart’s, compositions, such as by merely substituting the soy flour for textured soy protein, would improve texture and flavor.

C. Ground 2C: Rovaart, Conrad, Crane, Giacino

409. As discussed in Ground 1A, Giacino discloses a beef flavor composition containing cysteine and thiamine and the concentrations of claims 8-9 (though the concentrations lack patentable weight), and the cooking temperature and duration of claim 14. Section XI.A.8. As a result, the combination of Rovaart, Conrad, Crane, and Giacino render obvious claims 8-9 and claim 14.

410. It would have been obvious to combine Giacino’s meat-flavor compositions with Rovaart’s compositions. As already discussed, Rovaart, Conrad, Crane, and Giacino are all analogous art to the ’241 patent.

411. A POSITA would be motivated to make this combination. Rovaart already notes the desirability for products to have a “desired texture and taste” that is “meat-like.” EX1125(Rovaart), 1:39-41. Indeed, Rovaart notes that “[c]ysteine is preferred.” *Id.*, 1:68. Giacino itself notes “meat-like flavors are well-known” and there is “[c]onsiderable demand for meat-flavored products” without meat.

EX1015(Giacino), 1:26-31. Giacino’s “novel flavor compositions” thus provide “a marked meat flavor.” *Id.*, 2:47-48. Such compositions “can be used ... in a wide range of food stuffs ... as an aid in improving and enhancing existing flavor.” *Id.*, 1:65-67. Cysteine, especially, is “highly desirable,” although Giacino’s invention notes that only “small amounts of cysteine” need be used for beef flavors. *Id.*, 4:47-49, 5:17-18.

412. POSITAs were long-aware of the importance of amino acids (especially cysteine and thiamine) to produce meat flavors. MacLeod, a 1981 paper, provides a comprehensive overview of simulated meat flavorings known at the time, including “the importance of reducing sugars and amino acids,” especially cysteine and thiamine, to provide meat-like flavor and aroma. EX1024(Macleod), 399 (“Whenever cysteine was used, recognizable beef aroma resulted ...”); 409 (“Several patents stress the importance of thiamin as a meat flavor precursor”).

413. Based on these teachings, a POSITA was motivated to add Giacino’s beef-flavored composition to enhance the meat flavor of Rovaart’s composition analog composition. Rolan invites the addition of amino acids and recognizes the desirability of meat flavor, and Giacino provides compositions that achieve meat flavor via cysteine and thiamine. Combined with the glucose or ribose found in Rovaart’s compositions, a POSITA knew this combination would create a more desirable meat flavor when cooked. EX1005 (McGorin), ¶¶44-53;

EX1015(Giacino), 6:3-7 (“The presence of [ribose, sucrose, dextrose (i.e. glucose)] results in ... more intense flavor characteristics.”). This was also the application of a known technique to a known product ready for improvement, yielding the predictable result of enhanced meat flavor.

414. A POSITA would have a reasonable expectation of success given the specific instructions provided by Giacino in preparing its beef-flavored composition. EX1015, 9:70-10:14. A POSITA would reasonably expect that using the mixture in Giacino would result in a beef-flavored composition that could be successfully added to Rovaart’s compositions for enhanced beef flavoring.

D. Ground 2D: Rovaart, Conrad, Crane, Rolan

415. Rovaart, Conrad, and Crane combined with Rolan render obvious claims 11-12.

416. As I explained above in Ground 1C, Rolan teaches various antioxidants and flavoring agents. *See supra* Section XI.C. These antioxidants include the antioxidants in claim 11, such as “beta-carotene,” “caffeic acid,” and “tocopherols,”. EX1021 (Rolan), [0095]. The antioxidants also include “wheat germ oil,” which a POSITA would understand to be a vegetable oil, as claimed in claim 12. *Id.*; EX1144(Eisenmenger), 863 (“There is a need for the development of new processing techniques to facilitate **vegetable oil** extraction and refining In this study supercritical carbon dioxide ... extraction and fractionation techniques were

examined as alternative methods to obtain *wheat germ oil* (WGO) of high quality and purity.”).

417. A POSITA would understand that the Rovaart, Conrad, Crane combination could be modified and would be motivated to include other well-known flavoring and antioxidant agents to enhance and preserve the composition’s beef flavor/aroma using ordinary skill in the art with a reasonable expectation of success. As explained in Ground 1C, Rolan teaches various antioxidants and flavoring agents. *See supra* Section XI.C.

418. It would have been obvious to combine these antioxidants and flavoring agents from Rolan with Rovaart’s meat-like product and the Rovaart, Conrad, Crane compositions. Rolan, like Rovaart, Conrad, and Crane, is analogous art to the ’241 patent, as they are all directed to producing meat flavors in foodstuffs. EX1012(Brown), [0002], [0017]; EX1013, 1:11-14, 4:14-16; EX1014, Abstract, [0021], [0060]-[0062].

419. Rovaart, like Brown in Ground 1, teaches a POSITA to modify its composition to add various ingredients that enhance the meat-like flavor of Rovaart’s food products. *See supra* Section IX.A.1.c. Thus, for the same reasons explained in Ground 1C, a POSITA would be motivated to make this Rovaart, Conrad, Crane, Rolan combination to add Rolan’s antioxidant and flavoring agents to further enhance and preserve the Rovaart, Conrad, Crane composition’s beef

flavor/aroma and have the benefits of antioxidants. *See supra* Section XI.C. A POSITA would also have a reasonable expectation of success making this combination for the same reasons discussed for Brown in Ground 1C. *See supra* Section XI.C.

420. With respect to vegetable oils, Rolan also discloses that oils can be a type of “flavoring agent,” which “may provide an animal meat flavor, a grilled meat flavor, a rare beef flavor, etc.” EX1021, [0096]. Thus, a POSITA would have been motivated to combine Rolan with the Rovaart, Conrad, Crane combination to further enhance the meat-like flavor. A POSITA would have had a reasonable expectation of success in adding wheat germ oil because no more than routine skill (*e.g.*, measuring, mixing) would have been required.

XIII. GROUNDS 3A-3D: ROVAART, CONRAD, PROULX, RONAI, GIACINO, ROLAN

421. As I explain below, Rovaart in view of Conrad, and further in view of Proulx render obvious claims 1, 4-8, 10, 13-23 (Ground 3A). Rovaart in view of Conrad and Proulx, and further in view of Ronai renders obvious claims 2-3 (Ground 3B). Rovaart in view of Conrad and Proulx, and further in view of Giacino renders obvious claims 8-9 and 14 (Ground 3C). Rovaart in view of Conrad and Proulx, and further in view of Rolan renders obvious claims 11-12 (Ground 3D).

422. The primary difference between Grounds 2A-2D and Grounds 3A-3D is that Rovaart’s composition is combined with Proulx’s soy leghemoglobin instead

of Crane's recombinant hemoglobin. Below, I explain why a POSITA would be motivated to use Proulx's soy leghemoglobin with Rovaart's composition.

423. Another difference is that Proulx discloses Claim 7.

424. Other than the use of Proulx instead of Crane, the rest of the grounds are largely similar with those in Grounds 2A through Ground 2D.

A. Proulx is Analogous Art

425. Proulx is analogous art because, as recognized by the '241 patent Examiner, Proulx provides a motivation to fortify foodstuffs with heme iron. EX1019(Proulx). Proulx teaches that, e.g., “[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(Proulx), 1518. Recognizing that “incorporation of animal-sourced heme iron is often unfeasible because of economic costs or because [of] cultural and religious barriers” (EX1019(Proulx), 1521), Proulx teaches advantages of “use of plant hemoglobins for improving...human diet,” particularly leghemoglobin sourced from soybeans. EX1019(Proulx), 1521.

B. A POSITA Would Have Been Motivated to Combine Rovaart, Conrad, and Proulx to Achieve the Claimed Subject Matter

426. A POSITA would have been motivated to combine Rovaart, Conrad, and Proulx to achieve the subject matter of the challenged claims for a variety of

reasons. Generally, a POSITA would have been motivated to create a meat-flavored additive composition, such as those described in Rovaart, that closely mimics the attributes of conventionally sourced meat, including flavor, aroma, and beneficial nutritional aspects, so as to encourage consumption by consumers who ordinarily enjoy consuming conventionally sourced meat, but for health, environmental, and/or personal preferences (*e.g.*, religious) choose not to consume animal products. As described below, a POSITA would have recognized that including a heme-containing protein, such as leghemoglobin, in Rovaart's meaty flavoring compositions would achieve these goals.

427. First, a POSITA would have been motivated to mimic beneficial aspects of meat's nutritional content. Specifically, a POSITA would have recognized that meat (*e.g.*, beef) is an important dietary source of iron, which is supplied by heme-containing proteins. It was also well-known to a POSITA that heme iron has greater bioavailability than non-heme iron. *See, e.g.*, EX1019 (Proulx), 1518, 1520 (citing Lynch, S. R.; Dassenko, S. A.; Morck, T. A.; Beard, J. L.; Cook, J. D. *Soy protein products and heme iron absorption in humans*. Am. J. Clin. Nutr. (1985), 41, 13-20; citing Layrisse, M.; Martinez-Torres, C. *Model for measuring dietary absorption of heme iron: test with a complete meal*. Am. J. Clin. Nutr. 1972, 25, 401-411.). A POSITA would have recognized that prior art artificial meat flavoring compositions, such as those described in Rovaart are not significant

sources of iron, and, in particular, they are not significant sources of heme iron. In light of this, a POSITA would have recognized a need to fortify Rovaart's meaty flavoring compositions to better approximate the iron content of meat.

428. Proulx describes methods for supplementing foods with heme iron. As Proulx acknowledges, it was well-known in the art that iron bioavailability of heme iron is higher than non-heme iron. EX1019 (Proulx), 1518, 1520 (citing Lynch, S. R.; Dassenko, S. A.; Morck, T. A.; Beard, J. L.; Cook, J. D. *Soy protein products and heme iron absorption in humans*. Am. J. Clin. Nutr. (1985), 41, 13-20; citing Layrisse, M.; Martinez-Torres, C. *Model for measuring dietary absorption of heme iron: test with a complete meal*. Am. J. Clin. Nutr. 1972, 25, 401-411.). Proulx teaches that heme iron may be sourced from leghemoglobin found in soy root nodules. Notably, Proulx discloses that soy leghemoglobin “showed similar bioavailability” to that of bovine hemoglobin in a food product. *See, e.g.*, EX1019 (Proulx), Abstract.

429. In view of the foregoing, a POSITA would have been motivated to add isolated soy leghemoglobin as taught by Proulx into Rovaart's meaty flavoring compositions to fortify the compositions with heme iron, which has a significantly higher bioavailability than non-heme iron. Doing so would allow the meaty flavoring compositions to better mimic the nutritional profile (*e.g.*, iron content) of conventionally sourced meat and encourage consumers to consume meat substitutes

made with the fortified meat-flavored compositions. A POSITA would have been further motivated to use Proulx's leghemoglobin as a fortificant because of the "high heat stability of...[heme] iron." EX1019(Proulx), 1520, 1522. Additionally, Proulx teaches 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," which for efficiency and cost reasons would serve as an additional motivation to use soy leghemoglobin. *Id.*, 1522. For all of these reasons, a POSITA would have recognized that "plant hemoglobins may have great potential to be used as a fortificant for improving nutrition." *Id.*

430. I understand that Patent Owner also agrees that soy leghemoglobin serves as an iron fortificant in light of Proulx's teachings. I understand that Patent Owner stated in its "generally recognized as safe" (GRAS) submission to the FDA for the use of soy leghemoglobin that:

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. In particular, Patent Owner expressly relied on Proulx to show that it was known in the art that the bioavailability of iron in soy

leghemoglobin was equivalent to that of animal heme sources (*e.g.*, bovine myoglobin) in food. Hence, Patent Owner agrees that soy leghemoglobin has a nutritive value as a source of iron and that adding it to meat-flavored compositions would enhance their dietary profile.

431. Additionally, a POSITA would have been motivated to mimic the natural flavor and aroma of cooked meat in Rovaart's meaty flavoring compositions in order to increase the consumer's perception that the consumer is eating a familiar meat product while minimizing the undesirable environmental and other ramifications of conventional animal husbandry practices. As a POSITA would have recognized, one characteristic of conventionally obtained meat is that, when cooked, the meat produces a meaty aroma resulting from a complex profile of volatile chemical compounds created during the process of heating precursor compounds within the meat. EX1005(McGorin), Sections V.B, V.D. Thus, a POSITA would have been motivated to prepare a food flavor additive composition that provides a meaty flavor and aroma when added to the meat substitute product so as to mimic the flavors and aromas associated with cooked meat.

432. To achieve this goal, Rovaart teaches that heating reducing sugars, such as ribose or glucose, with cysteine, and potentially other flavor precursors produces a meaty flavoring composition having a "meat-like flavour." *See, e.g.*, EX1125(Rovaart), Abstract, 1:39-40, 2:40-41, 3:11-12. Similarly, Conrad expressly

teaches that “[t]he addition of blood/hemoglobin further gives a desired taste improvement as it improves the meat flavour of the final product.” EX1013(Conrad), 4:14-16. Conrad teaches that hemoglobin can be isolated from blood before being added to the product. *Id.*, 4:7-9 (“preferably the hemoglobin part separated off from blood, the protein content of which is about 90% by weight”). A POSITA would have understood that, like bovine hemoglobin, soy leghemoglobin is also a heme-containing protein and would thus improve “meat-like flavour” as taught by Conrad. Hence, a POSITA would have been motivated to include soy leghemoglobin in Rovaart’s compositions for the additional reason of improving their flavor profile.

433. Accordingly, whether to fortify the composition with heme iron *and/or* to enhance meat flavor, a POSITA would have been motivated to add soy leghemoglobin to Rovaart’s compositions.

434. Moreover, given soy leghemoglobin is a plant protein (*e.g.*, soy), a POSITA would have understood that soy leghemoglobin provides a non-animal source of heme iron, which obviates the need to rely on heme-containing proteins obtained physically from animals (*e.g.*, bovine myoglobin or hemoglobin) that are associated with conventional animal husbandry. This would have been appealing to consumers who desired a vegetarian product for health or religious reasons and/or those concerned about the environmental impacts of conventional animal husbandry.

435. In view of the foregoing, a POSITA would have been motivated to combine the teachings of Rovaart, Conrad, and Proulx to modify Rovaart's meaty flavoring compositions to include soy leghemoglobin.

C. A POSITA Would Have Had a Reasonable Expectation of Success When Combining Rovaart, Conrad, and Proulx

436. A POSITA would have had a reasonable expectation of success in combining the teachings of Rovaart, Conrad, and Proulx to achieve the claimed invention.

437. First, only ordinary skill would have been required to prepare and assemble the ingredients taught in these references into a meat-like flavoring composition. Rovaart discloses detailed ingredient lists, including amounts and process steps, for its meat-like flavoring compositions. Proulx teaches conventional extraction methods for obtaining soybean leghemoglobin from plants for use in foodstuffs, which would require only ordinary skill to practice. For example, Proulx teaches that root nodules "were mechanically harvested...[and] ground...[T]he aqueous extract was also used to prepare partially purified LHb...by using...precipitation... Ion exchange chromatography...was used to further purify the LHb obtained from...precipitation." EX1019(Proulx), 1519 (describing "LHb Preparation" and bioavailability study design). Only ordinary skill would have been required to follow these steps. *See* EX1019(Proulx), 1519. Similarly, only ordinary

skill (*e.g.*, mixing) would have been needed to add the isolated soy leghemoglobin to Rovaart's meaty flavoring compositions.

438. Second, as explained further above, the chemistry of the Maillard reaction was long known, including the identity of specific precursor compounds that, when reacted with heat, would produce a meaty flavor and aroma. *See supra*, Section VII.D; EX1005(McGorin), Sections V.B, V.D. As taught in Rovaart, a POSITA would have been motivated to use reducing sugars, such as ribose, and sulfur compounds, such as thiamine and cysteine, to serve as precursors for the Maillard reaction (and other chemical reactions that occur during cooking), as the Maillard reaction was long known to produce volatile compounds associated with a desirable meaty flavor and aroma.

D. Ground 3A: Rovaart, Conrad, Proulx

1. Claim 1

439. As I discussed in Ground 2A, it is my opinion that Rovaart discloses limitations 1[pre], 1[a], 1[c]-1[d], 1[e] (with respect to non-heme ingredients), and 1[f]-1[g]. Section XII.A.1.

440. Rovaart, Conrad, and Proulx render obvious limitations 1[b] and 1[e], *i.e.* a non-animal heme-containing protein. As already discussed, Rovaart, Conrad, and Proulx are analogous art to the '241 patent.

441. As discussed above, a POSITA would have added recombinant plant

leghemoglobin to Giacino's compositions. *See supra*, X1. As to the specific type of leghemoglobin added, it would have been obvious to use soy leghemoglobin (*i.e.*, *Glycine max* leghemoglobin) based on Proulx's teachings.

442. Proulx discloses the use of soy leghemoglobin as an iron fortificant for foods. EX1019(Proulx), Abstract. Proulx also teaches that soy leghemoglobin "showed similar bioavailability" to that of bovine hemoglobin in a food product. *Id.*

443. Thus, a POSITA would have been motivated to use soy leghemoglobin as the hemoglobin of choice because it would have predictably provided heme iron having a bioavailability on par with bovine hemoglobin. It would have also been obvious to try using soy leghemoglobin based on the finite number of hemoglobins to choose from. A POSITA would have also had a reasonable expectation of success at recombinantly expressing and using soy leghemoglobin, which would have required no more than conventional techniques (*e.g.*, use of known soy leghemoglobin sequence in a recombinant expression system and mixing the expressed soy leghemoglobin into the meaty flavoring composition).

444. As discussed above, there were several teachings in Conrad and Proulx that would motivate a POSITA to use Proulx's leg hemoglobin in a food product, including Rovaart's food product. These included the known nutritional aspects of heme iron and the meat-like flavor and aroma of leghemoglobin. All of these teachings also apply to Rovaart, since it lacks a source of iron and also teaches

adding meaty flavor to products through “suitable flavouring agents ... which may be natural,” which a POSITA would know includes leg hemoglobins. EX1125(Rovaart), 1:24-29. Rovaart also teaches the desirability of enhancing—not merely producing—meaty flavor, such as noting “less pronounced” meaty flavors are undesirable. EX1125(Rovaart), 6:16-28.

445. A POSITA would have had a reasonable expectation of success in combining Rovaart, Conrad, and Proulx to achieve the claimed invention. Only ordinary skill would have been required to prepare and assemble the ingredients taught in these references into a meaty flavoring composition. Similarly, only ordinary skill would have been required to carry out Proulx’s process steps for harvesting and purifying soy leghemoglobin. The Maillard reaction was also long known, including the identity of specific precursor compounds that, when reacted with heat, would produce a meaty flavor and aroma.

2. Claims 4-5

446. As I discuss above, these terms do not have patentable weight. Section X.C. But as I also discussed, a POSITA would understand that Proulx’s disclosure of 73% hemoglobin purity refers to 73% of the isolated protein on a dry weight basis. *Id.*; EX1019, 1519-20.

3. Claim 6

447. As I discussed previously, Proulx’s leghemoglobin is a globin.

4. Claim 7

448. The '241 patent identifies the polypeptide of SEQ ID NO 4 as Glycine max leghemoglobin (i.e. soy leghemoglobin). EX1001, 10:50-51.

449. As discussed above, Proulx discloses soy leghemoglobin, which is the same polypeptide as the '241 patent's SEQ ID NO 4. Proulx's soy leghemoglobin therefore meets this claim.

5. Claims 8, 10, 13-21

450. It is my opinion that these claims are rendered obvious because they are disclosed by Rovaart as discussed in Ground 2A. *See supra*, Section XII.A.

6. Claims 22-23

451. It is my opinion that Claim 22 is rendered obvious for the same reasons discussed in claim 1, excluding the analysis of Proulx and Rovaart's disclosure of the concentration limitations, since claim 22 does not have those limitations. Claim 23 is also rendered obvious for the reasons discussed in Claim 1 (Section XIII.D.1) and Ground 2A (Section XII.A)—specifically, Proulx's leg hemoglobin is a non-animal protein and Rovaart's Example 1 lacks animal products.

E. Ground 3B: Rovaart, Conrad, Proulx, Ronai

452. As discussed in Ground 2B, Ronai discloses claims 2-3 and it would have been obvious to combine Rovaart with Ronai, and this is so even with the use of Proulx's leghemoglobin. *See supra*, Section XII.B.

F. Ground 3C: Rovaart, Conrad, Proulx, Giacino

453. As discussed in Ground 2C, Giacino discloses claims 8-9 and 14 and it would have been obvious to combine Rovaart with Giacino, and this is so even with the use of Proulx's leghemoglobin. *See supra*, Section XII.C.

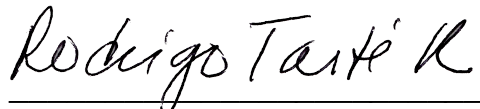
G. Ground 3D: Rovaart, Conrad, Proulx, Perret

454. As discussed in Ground 2D, Perret discloses claim 12 and it would have been obvious to combine Rovaart with Perret, and this is so even with the use of Proulx's leghemoglobin. *See supra*, Section XII.D.

XIV. Conclusion

455. 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 crossexamination 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. 5, 2022

Date