

**UNITED STATES PATENT AND TRADEMARK OFFICE**

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**BEFORE THE PATENT TRIAL AND APPEAL BOARD**

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MOTIF FOODWORKS, INC.,

Petitioner,

v.

IMPOSSIBLE FOODS INC.,  
Patent Owner.

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

**“METHODS AND COMPOSITIONS FOR CONSUMABLES”**

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*Inter Partes* Review No. 2023-00209

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**PETITION FOR *INTER PARTES* REVIEW OF  
U.S. PATENT NO. 10,039,306  
UNDER 35 U.S.C. §§ 311-319 AND 37 C.F.R. §§ 42.100 *et seq.***

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**EXHIBITS**

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| <b>EX1001</b> | U.S. Patent No. 9,943,096 to Fraser et al.                                                                                                                       |
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| <b>EX1012</b> | International Pub. No. WO 2013/010042 A1 to Brown et al., published January 17, 2013                                                                             |
| <b>EX1013</b> | U.S. Patent No. 4,818,557 to Conrad, issued April 4, 1989                                                                                                        |
| <b>EX1014</b> | U.S. Patent Publication No. 2011/0287467 A1 to Crane et al., published November 24, 2011                                                                         |
| <b>EX1015</b> | U.S. Patent No. 3,519,437 to Giacino, issued July 7, 1970                                                                                                        |
| <b>EX1016</b> | Boye et al., <i>Pulse Proteins: Processing, Characterization, Functional Properties and Applications in Food and Feed</i> , 43 FOOD RESEARCH INT’L 414-31 (2010) |

| No.           | Exhibit                                                                                                                                                      |
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| <b>EX1017</b> | Mottram, <i>Flavour Formation in Meat and Meat Products: A Review</i> , 62 FOOD CHEM. 415-24 (1998)                                                          |
| <b>EX1019</b> | Proulx & Reddy, <i>Iron Bioavailability of Hemoglobin from Soy Root Nodules Using a Caco-2 Cell Culture Model</i> , 54 J. AGRIC. & FOOD CHEM. 1518-22 (2006) |
| <b>EX1021</b> | U.S. Patent Publication No. 2008/0268112 A1 to Rolan et al., published October 30, 2008                                                                      |
| <b>EX1022</b> | U.S. Patent Publication No. 2008/0026128 A1 to Yamaguchi et al., published January 31, 2008                                                                  |
| <b>EX1024</b> | MacLeod et al., <i>Natural and Simulated Meat Flavors (with Particular Reference to Beef)</i> , 14 CRITICAL REVIEWS IN FOOD SCI. & NUTRITION 309-437 (1981)  |
| <b>EX1025</b> | U.S. Provisional No. 61/751,816, filed January 11, 2013                                                                                                      |
| <b>EX1026</b> | Dwivedi & Brockman, <i>Meat Flavor</i> , 5 CRITICAL REVIEWS IN FOOD SCI. & NUTRITION 487-535 (1981)                                                          |
| <b>EX1027</b> | Pearson & Gillett, PROCESSED MEATS Ch. 3 (3d ed. 1996)                                                                                                       |
| <b>EX1028</b> | Calkins & Hodgen, <i>A Fresh Look at Meat Flavor</i> , 77 MEAT SCI. 63-80 (2007)                                                                             |
| <b>EX1029</b> | Williamson et al., <i>Red Meat in the Diet</i> , 30 NUTRITION BULLETIN 323-55 (2005)                                                                         |
| <b>EX1030</b> | Garrocho-Villegas et al., <i>Plant Hemoglobins: What We Know A Six Decades after Their Discovery</i> , 398 GENE 78-85 (2007)                                 |
| <b>EX1031</b> | McGorin, <i>The Significance of Volatile Sulfur Compounds in Food Flavors</i> , in VOLATILE SULFUR COMPOUNDS IN FOOD 3-31 (Qian et al., eds., 2011)          |

| No.           | Exhibit                                                                                                                                                                             |
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| <b>EX1032</b> | Cerny & Davidek, <i>Formation of Aroma Compounds from Ribose and Cysteine during the Maillard Reaction</i> , 51 J. AGRIC. FOOD CHEM. 2714-21 (2003)                                 |
| <b>EX1033</b> | Reineccius, FLAVOR CHEMISTRY AND TECHNOLOGY CH. 5 (2d ed. 2006)                                                                                                                     |
| <b>EX1034</b> | Reineccius, FLAVOR CHEMISTRY AND TECHNOLOGY CH. 9 (2d ed. 2006)                                                                                                                     |
| <b>EX1035</b> | Verbeke & Viaene, <i>Ethical Challenges for Livestock Production: Meeting Consumer Concerns about Meat Safety and Animal Welfare</i> , 12 J. OF AGRIC. & ENV'T ETHICS 141-51 (2000) |
| <b>EX1036</b> | Pimentel & Pimentel, <i>Sustainability of Meat-Based and Plant-Based Diets and the Environment</i> , 78 AM. J. CLINICAL NUTRITION 660S-63S (2003)                                   |
| <b>EX1038</b> | Manley, <i>Process Flavors</i> , in SOURCE BOOK OF FLAVORS 139-54 (G. Reineccius ed., 2d ed. 1999)                                                                                  |
| <b>EX1039</b> | McGorrin, <i>Character-Impact Flavor and Off-Flavor Compounds in Foods</i> , in FLAVOR, FRAGRANCE, AND ODOR ANALYSIS 207-62 (R. Marsili ed., 2d ed. 2012)                           |
| <b>EX1041</b> | Bailey, <i>The Maillard Reaction and Meat Flavor</i> , in THE MAILLARD REACTION IN FOODS AND NUTRITION 169-84 (Waller & Feather, eds., 1983)                                        |
| <b>EX1043</b> | Dreher et al., <i>GC–Olfactometric Characterization of Aroma Volatiles from the Thermal Degradation of Thiamin in Model Orange Juice</i> , 51 J. AGRIC. FOOD CHEM. 3097-102 (2003)  |

| No.    | Exhibit                                                                                                                                                                                                                                                                          |
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| EX1045 | Hofmann & Schieberle, <i>Evaluation of the Key Odorants in a Thermally Treated Solution of Ribose and Cysteine by Aroma Extract Dilution Techniques</i> , 43 J. AGRIC. FOOD CHEM. 2187-2194 (1995)                                                                               |
| EX1046 | Goto et al., <i>Iron Fortification of Rice Seed by the Soybean Ferritin Gene</i> , 17 NATURE BIOTECH. 282-86 (1999)                                                                                                                                                              |
| EX1047 | Zhu & Cadwallader, <i>Streamlined Approach for Careful and Exhaustive Aroma Characterization of Aged Distilled Liquors</i> , 3 Food Chem.: X 100038 (2019)                                                                                                                       |
| EX1048 | Pearson & Gray, <i>Mechanism Responsible for Warmed-Over Flavor in Cooked Meat</i> , in THE MAILLARD REACTION IN FOODS AND NUTRITION 287-300 (Waller & Feather eds., 1983)                                                                                                       |
| EX1049 | Hofmann & Schieberle, <i>Quantitative Model Studies on the Effectiveness of Different Precursor Systems in the Formation of the Intense Food Odorants 2-Furfurylthiol and 2-Methyl-3-furanthiol</i> , 46 J. AGRIC. FOOD CHEM. 235-41 (1998)                                      |
| EX1051 | Hofmann et al., <i>Model Studies on the Oxidative Stability of Odor-Active Thiols Occurring in Food Flavors</i> , 44 J. AGRIC. FOOD CHEM. 251-55 (1996)                                                                                                                          |
| EX1052 | GRAS Notice No. 737: GRAS Notification for Soy Leghemoglobin Protein Preparation Derived from Pichia Pastoris, submitted by Impossible Foods Inc. (Oct. 2, 2017), available at <a href="https://www.fda.gov/media/124351/download">https://www.fda.gov/media/124351/download</a> |
| EX1056 | Klesk & Qian, <i>Aroma Extract Dilution Analysis of Cv. Marion (Rubus spp. hyb) and Cv. Evergreen (R. laciniatus L.) Blackberries</i> , 51 J. AGRIC. FOOD CHEM. 3436-41 (2003)                                                                                                   |

| No.           | Exhibit                                                                                                                                                                                                                                                                                                           |
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| <b>EX1060</b> | Marchand et al., <i>Possible Mechanism for Involvement of Cysteine in Aroma Production in Wine</i> , 50 J. AGRIC. & FOOD CHEM. 6160-64 (2002)                                                                                                                                                                     |
| <b>EX1064</b> | Splivallo et al., <i>Bacteria Associated with Truffle-Fruiting Bodies Contribute to Truffle Aroma</i> , 17 ENV'T MICROBIOLOGY 2647-60 (2015)                                                                                                                                                                      |
| <b>EX1084</b> | Fellows, FOOD PROCESSING TECHNOLOGY: PRINCIPLES AND PRACTICE Ch. 6 (3d ed. 2009)                                                                                                                                                                                                                                  |
| <b>EX1087</b> | Williams, <i>Nutritional Composition of Red Meat</i> , 64 NUTRITION & DIETETICS: J. OF THE DIETITIANS ASSOC. OF AUSTL. S113 (2007)                                                                                                                                                                                |
| <b>EX1093</b> | Vauthey et al., <i>Structured Fluids as Microreactors for Flavor Formation by the Maillard Reaction</i> , 48 J. AGRIC. & FOOD CHEM. 4808-16 (2000)                                                                                                                                                                |
| <b>EX1094</b> | Suman & Joseph, <i>Myoglobin Chemistry and Meat Color</i> , 4 ANN. REV. FOOD SCI. & TECH. 79-99 (2013)                                                                                                                                                                                                            |
| <b>EX1095</b> | Withycombe & Mussinan, <i>Identification of 2-Methyl-3-Furanthiol in the Steam Distillate from Canned Tuna Fish</i> , 53 J. FOOD SCI. 658 (1988)                                                                                                                                                                  |
| <b>EX1096</b> | Kerscher & Grosch, <i>Quantification of 2-Methyl-3-furanthiol, 2-Furfurylthiol, 3-Mercapto-2-pentanone, and 2-Mercapto-3-pentanone in Heated Meat</i> , 46 J. AGRIC. FOOD CHEM. 1954-58 (1958)                                                                                                                    |
| <b>EX1098</b> | Zyzak et al., <i>Investigation into the Sensorial and Analytical Differences of Traditional Hamburgers Versus the Plant-Based Analogues</i> , presentation at ACS Fall 2021, available at <a href="https://acs.digitellinc.com/acs/sessions/169689/view">https://acs.digitellinc.com/acs/sessions/169689/view</a> |

| No.           | Exhibit                                                                                                                                                                                                                                                                                                                                                                                                      |
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| <b>EX1099</b> | Mottram, <i>The Maillard Reaction: Source of Flavour in Thermally Processed Foods</i> , in FLAVOURS AND FRAGRANCES 269-83 (Berger ed., 2007)                                                                                                                                                                                                                                                                 |
| <b>EX1100</b> | Ulrich et al., <i>Investigation of the Boiled Potato Flavor by Human Sensory and Instrumental Methods</i> , 77 AM. J. POTATO RSCH. 111-17 (2000)                                                                                                                                                                                                                                                             |
| <b>EX1107</b> | <i>What Gives Meat its Color?</i> , EXPLORATORIUM: SCIENCE OF COOKING, <a href="https://www.exploratorium.edu/cooking/meat/INT-what-meat-color.html">https://www.exploratorium.edu/cooking/meat/INT-what-meat-color.html</a>                                                                                                                                                                                 |
| <b>EX1108</b> | Cysteine, PUBCHEM, <a href="https://pubchem.ncbi.nlm.nih.gov/compound/5862">https://pubchem.ncbi.nlm.nih.gov/compound/5862</a>                                                                                                                                                                                                                                                                               |
| <b>EX1109</b> | Maltodextrin, PUBCHEM, <a href="https://pubchem.ncbi.nlm.nih.gov/compound/Maltodextrin-dextrose-equivalent-10-15">https://pubchem.ncbi.nlm.nih.gov/compound/Maltodextrin-dextrose-equivalent-10-15</a>                                                                                                                                                                                                       |
| <b>EX1110</b> | Thiamine, PUBCHEM, <a href="https://pubchem.ncbi.nlm.nih.gov/compound/1130">https://pubchem.ncbi.nlm.nih.gov/compound/1130</a>                                                                                                                                                                                                                                                                               |
| <b>EX1111</b> | Ribose, PUBCHEM, <a href="https://pubchem.ncbi.nlm.nih.gov/compound/D-Ribose">https://pubchem.ncbi.nlm.nih.gov/compound/D-Ribose</a>                                                                                                                                                                                                                                                                         |
| <b>EX1112</b> | Sucrose, PUBCHEM, <a href="https://pubchem.ncbi.nlm.nih.gov/compound/Sucrose">https://pubchem.ncbi.nlm.nih.gov/compound/Sucrose</a>                                                                                                                                                                                                                                                                          |
| <b>EX1113</b> | <i>Organoleptic</i> , COLLINS, <a href="https://www.collinsdictionary.com/us/dictionary/english/organoleptic">https://www.collinsdictionary.com/us/dictionary/english/organoleptic</a>                                                                                                                                                                                                                       |
| <b>EX1114</b> | <i>Sniffing Out which Plant-Based Burgers Smell the Most Like Real Beef</i> , AM. CHEM. SOC'Y, <a href="https://www.acs.org/content/acs/en/pressroom/newsreleases/2021/august/sniffing-out-which-plant-based-burgers-smell-the-most-like-real-beef.html">https://www.acs.org/content/acs/en/pressroom/newsreleases/2021/august/sniffing-out-which-plant-based-burgers-smell-the-most-like-real-beef.html</a> |
| <b>EX1115</b> | d'Estries, <i>Science Reveals Which Plant-Based Burger Smells Closest to the Real Thing</i> , TREEHUGGER,                                                                                                                                                                                                                                                                                                    |

| No.           | Exhibit                                                                                                                                                                                                                                                                                                                                                                                 |
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|               | <a href="https://www.treehugger.com/science-reveals-plant-based-burger-smells-5200260">https://www.treehugger.com/science-reveals-plant-based-burger-smells-5200260</a>                                                                                                                                                                                                                 |
| <b>EX1116</b> | Second Amended Complaint for Damages and Injunctive Relief, <i>Impossible Foods Inc. v. Motif Foodworks, Inc.</i> , Case No. 1:22-cv-00311-CFC, D.I. 22 (D. Del. Sept. 7, 2022)                                                                                                                                                                                                         |
| <b>EX1118</b> | Wang et al., <i>Reinvestigation of 2-acetylthiazole Formation Pathways in the Maillard Reaction</i> , 345 FOOD CHEM. 128761 (2021)                                                                                                                                                                                                                                                      |
| <b>EX1119</b> | Boelens & Gemert, <i>Volatile Character-Impact Sulfur Compounds and Their Sensory Properties</i> , 18 PERFUMER & FLAVORIST 29-39 (1993)                                                                                                                                                                                                                                                 |
| <b>EX1120</b> | Adam McQueen, <i>Beyond Meat vs. Impossible Foods: The Very Real Battle Between the Biggest ‘Fake-Meat’ Competitors</i> , KLUE, <a href="https://klue.com/blog/beyond-meat-vs-impossible-foods-the-very-real-battle-between-the-biggest-fake-meat-competitors">https://klue.com/blog/beyond-meat-vs-impossible-foods-the-very-real-battle-between-the-biggest-fake-meat-competitors</a> |
| <b>EX1121</b> | Pat Brown, <i>Heme, Health, and the Plant-Based Diet</i> , IMPOSSIBLE, <a href="https://impossiblefoods.com/blog/heme-health-the-essentials">https://impossiblefoods.com/blog/heme-health-the-essentials</a>                                                                                                                                                                            |
| <b>EX1123</b> | <i>Meat Consumption</i> , OECD (2022), <a href="https://data.oecd.org/agroutput/meat-consumption.htm">https://data.oecd.org/agroutput/meat-consumption.htm</a>                                                                                                                                                                                                                          |
| <b>EX1125</b> | U.S. Patent No. 3,930,044 to van de Rovaart et al., issued December 30, 1975                                                                                                                                                                                                                                                                                                            |
| <b>EX1126</b> | <i>Flour, soy, defatted</i> , FoodData Central, U.S. DEP’T OF AGRIC., <a href="https://fdc.nal.usda.gov/fdc-app.html#/food-details/1104705/nutrients">https://fdc.nal.usda.gov/fdc-app.html#/food-details/1104705/nutrients</a>                                                                                                                                                         |
| <b>EX1129</b> | Mottram, <i>Volatile Compounds from the Reaction of Cysteine, Ribose, and Phospholipid in Low-Moisture Systems</i> , 43 J. AGRIC. FOOD CHEM. 984-88 (1995)                                                                                                                                                                                                                              |

| No.           | Exhibit                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>EX1133</b> | Hargrove et al., <i>Characterization of Recombinant Soybean Leghemoglobin a and Apolar Distal Histidine Mutants</i> , 266 J. MOLECULAR BIOLOGY 1032-42 (1997)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>EX1135</b> | Nicola & Leach, <i>Structural Rearrangements Due to Ligand Binding and Haem Replacement in Myoglobin and Leghaemoglobins</i> , 78 EUROPEAN J. BIOCHEM. 133-40 (1977)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>EX1137</b> | Batt et al., <i>Expression of Recombinant Bovine <math>\beta</math>-Lactoglobulin in Escherichia coli</i> , 54 AGRIC. & BIOLOGICAL CHEM. 949-55 (1990)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>EX1138</b> | Jamieson et al., <i>Cloning and Nucleotide Sequence of the Bovine <math>\beta</math>-Lactoglobulin Gene</i> , 61 GENE 85-90 (1987)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>EX1139</b> | Weed et al., <i>Is Hemoglobin an Essential Structural Component of Human Erythrocyte Membranes?</i> , 42 J. CLINICAL INVESTIGATION 581-88 (1963)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>EX1140</b> | U.S. Patent Publication No. US 2008/0008815 A1 to Cho, published January 10, 2008.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>EX1141</b> | Evers et al., <i>Furan Substituted at the Three Position with Sulfur</i> , in PHENOLIC, SULFUR, AND NITROGEN COMPOUNDS IN FOOD FLAVORS SYMPOSIUM 184-93 (1976)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>EX1146</b> | <i>Sniffing Out which Plant-Based Burgers Smell the Most Like Real Beef</i> (Video), AM. CHEM. SOC'Y, available at <a href="https://www.youtube.com/watch?v=3W_0GqGnsN4&amp;list=PPSV">https://www.youtube.com/watch?v=3W_0GqGnsN4&amp;list=PPSV</a>                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>EX1147</b> | T.L. Stanley, <i>Impossible Foods Hires a Veteran of Apple Ads to Beef Up its Creative Marketing</i> , ADWEEK, <a href="https://www.adweek.com/brand-marketing/impossible-foods-hires-a-veteran-of-apple-ads-to-beef-up-its-creative-marketing/#:~:text=Impossible%20Foods%20Hires%20a%20Veteran%20of%20Apple%20Ads,record.%20Impossible%20By%20T.L.%20Stanley%20April%202013%2C%202021">https://www.adweek.com/brand-marketing/impossible-foods-hires-a-veteran-of-apple-ads-to-beef-up-its-creative-marketing/#:~:text=Impossible%20Foods%20Hires%20a%20Veteran%20of%20Apple%20Ads,record.%20Impossible%20By%20T.L.%20Stanley%20April%202013%2C%202021</a> |
| <b>EX1148</b> | Prosecution History of U.S. Patent No. 10,039,306 to Vrljic et al.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

| No.    | Exhibit                                                                                                                                                 |
|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| EX1149 | Prosecution History of U.S. Patent No. 11,013,250 to Vrljic et al.                                                                                      |
| EX1150 | Prosecution History of U.S. Patent No. 11,224,241 to Fraser et al.                                                                                      |
| EX1151 | Ames, <i>Control of the Maillard Reaction in Food Systems</i> , 1 TRENDS IN FOOD SCI. & TECH. 150-54 (1990)                                             |
| EX1152 | <i>Methionine</i> , PUBCHEM,<br><a href="https://pubchem.ncbi.nlm.nih.gov/compound/Methionine">https://pubchem.ncbi.nlm.nih.gov/compound/Methionine</a> |
| EX1156 | U.S. Patent No. 9,943,096 to Fraser et al.                                                                                                              |
| EX1158 | U.S. Patent No. 11,013,250 to Vrljic et al.                                                                                                             |
| EX1159 | U.S. Patent No. 11,224,241 to Fraser et al.                                                                                                             |

## LIST OF CHALLENGED CLAIMS

| Claim 1                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                             |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Element No.                                                                                                                                                                                                                                                                                         | Claim Limitation                                                                                                                                                                                            |
| <b>1[pre]</b>                                                                                                                                                                                                                                                                                       | A method for imparting a beef-like aroma to a meat replica matrix,                                                                                                                                          |
| <b>1[a]</b>                                                                                                                                                                                                                                                                                         | wherein the meat replica matrix comprises one or more plant proteins,                                                                                                                                       |
| <b>1[b]</b>                                                                                                                                                                                                                                                                                         | sugar selected from glucose, ribose, sucrose, fructose, xylose, maltodextrin, and combinations thereof, and at least one sulfur compound selected from methionine, cysteine and thiamine,                   |
| <b>1[c]</b>                                                                                                                                                                                                                                                                                         | the method comprising adding 0.01%-5% (by weight of the meat replica matrix) of a non-animal heme-containing protein to the meat replica matrix,                                                            |
| <b>1[d]</b>                                                                                                                                                                                                                                                                                         | wherein, upon cooking of the meat replica matrix, at least two volatile compounds are generated that are associated with a beef-like aroma, thereby imparting a beef-like aroma to the meat replica matrix. |
| Claim 3                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                             |
| The method of claim 1, wherein the non-animal heme-containing protein has a UV-VIS spectrum that is substantially similar to that of myoglobin from an animal.                                                                                                                                      |                                                                                                                                                                                                             |
| Claim 4                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                             |
| The method of claim 1, wherein the heme-containing protein is selected from the group consisting of a leghemoglobin, a flavohemoglobin, Hell's gate globin I, an erythrocrucorin, a protoglobin, a cyanoglobin, a chlorocrucorin, a truncated hemoglobin, a truncated 2/2 globin, and a hemoglobin. |                                                                                                                                                                                                             |
| Claim 5                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                             |

|                                                                                                                                                                                                                                                                                                                  |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| The method of claim 1, comprising incorporating into the meat replica matrix 0.4%-1% (by weight of the meat replica matrix) of the non-animal heme-containing protein.                                                                                                                                           |
| <b>Claim 6</b>                                                                                                                                                                                                                                                                                                   |
| The method of claim 1, wherein the non-animal heme-containing protein is purified.                                                                                                                                                                                                                               |
| <b>Claim 7</b>                                                                                                                                                                                                                                                                                                   |
| The method of claim 1, wherein at least one of the one or more plant proteins is isolated.                                                                                                                                                                                                                       |
| <b>Claim 8</b>                                                                                                                                                                                                                                                                                                   |
| The method of claim 7, wherein at least one of the one or more isolated plant proteins is purified.                                                                                                                                                                                                              |
| <b>Claim 9</b>                                                                                                                                                                                                                                                                                                   |
| The method of claim 1, wherein the one or more plant proteins are selected from the group consisting of rubisco, pea proteins, lentil proteins, and other legume proteins.                                                                                                                                       |
| <b>Claim 10</b>                                                                                                                                                                                                                                                                                                  |
| The method of claim 9, wherein the pea proteins comprise pea albumin proteins.                                                                                                                                                                                                                                   |
| <b>Claim 11</b>                                                                                                                                                                                                                                                                                                  |
| The method of claim 1, wherein the one or more plant proteins are present in the meat replica matrix in an amount of between 1% and 30% (by weight of the meat replica matrix).                                                                                                                                  |
| <b>Claim 13</b>                                                                                                                                                                                                                                                                                                  |
| The method of claim 1, wherein the meat replica matrix is comprised within a consumable product, wherein the consumable product is selected from taco filling, a casserole, a sauce, a topping, soup, stew, and a loaf, wherein, upon cooking of the consumable product, the at least two volatile compounds are |

|                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                 |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| generated in substantially higher amounts than upon cooking of the consumable product lacking the meat replica matrix.                                                                                                                                                                               |                                                                                                                                                                                                                 |
| <b>Claim 14</b>                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                 |
| <b>14[pre]</b>                                                                                                                                                                                                                                                                                       | A method for making a meat replica matrix having a beef-like aroma,                                                                                                                                             |
| <b>14[a]</b>                                                                                                                                                                                                                                                                                         | wherein the meat replica matrix comprises one or more plant proteins,                                                                                                                                           |
| <b>14[b]</b>                                                                                                                                                                                                                                                                                         | a sugar selected from glucose, ribose, sucrose, fructose, xylose, maltodextrin, and combinations thereof, and at least one sulfur compound selected from methionine, cysteine and thiamine,                     |
| <b>14[c]</b>                                                                                                                                                                                                                                                                                         | the method comprising obtaining a non-animal heme-containing protein; and incorporating 0.01%-5% (by weight of the meat replica matrix) of the non-animal heme-containing protein into the meat replica matrix, |
| <b>14[d]</b>                                                                                                                                                                                                                                                                                         | wherein, upon cooking of the meat replica matrix, at least two volatile compounds are generated that are associated with a beef-like aroma.                                                                     |
| <b>Claim 16</b>                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                 |
| The method of claim 14, wherein the non-animal heme-containing protein has a UV-VIS spectrum that is substantially similar to that of myoglobin from an animal.                                                                                                                                      |                                                                                                                                                                                                                 |
| <b>Claim 17</b>                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                 |
| The method of claim 14, wherein the heme-containing protein is selected from the group consisting of a leghemoglobin, a flavohemoglobin, Hell's gate globin I, an erythrocrucorin, a protoglobin, a cyanoglobin, a chlorocrucorin, a truncated hemoglobin, a truncated 2/2 globin, and a hemoglobin. |                                                                                                                                                                                                                 |
| <b>Claim 18</b>                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                 |
| The method of claim 14, comprising incorporating 0.4-1% (by weight of the meat replica matrix) of the non-animal heme-containing protein into the meat replica matrix.                                                                                                                               |                                                                                                                                                                                                                 |

|                                                                                                                                                                                                                                                                                                                                                                                                                           |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Claim 19</b>                                                                                                                                                                                                                                                                                                                                                                                                           |
| The method of claim 14, wherein at least one of the one or more plant proteins is isolated.                                                                                                                                                                                                                                                                                                                               |
| <b>Claim 20</b>                                                                                                                                                                                                                                                                                                                                                                                                           |
| The method of claim 19, wherein at least one of the one or more isolated plant proteins is purified.                                                                                                                                                                                                                                                                                                                      |
| <b>Claim 21</b>                                                                                                                                                                                                                                                                                                                                                                                                           |
| The method of claim 14, wherein the one or more plant proteins are selected from the group consisting of rubisco, pea proteins, lentil proteins, and other legume proteins.                                                                                                                                                                                                                                               |
| <b>Claim 22</b>                                                                                                                                                                                                                                                                                                                                                                                                           |
| The method of claim 21, wherein the pea proteins comprise pea albumin proteins.                                                                                                                                                                                                                                                                                                                                           |
| <b>Claim 23</b>                                                                                                                                                                                                                                                                                                                                                                                                           |
| The method of claim 14, wherein the one or more plant proteins are present in the meat replica matrix in an amount of between 1% and 30% (by weight of the meat replica matrix).                                                                                                                                                                                                                                          |
| <b>Claim 24</b>                                                                                                                                                                                                                                                                                                                                                                                                           |
| The method of claim 14, wherein the non-animal heme-containing protein is purified.                                                                                                                                                                                                                                                                                                                                       |
| <b>Claim 26</b>                                                                                                                                                                                                                                                                                                                                                                                                           |
| The method of claim 14, wherein the meat replica matrix is comprised within a meat replica composition, wherein the composition is selected from taco filling, a casserole, a sauce, a topping, soup, stew, and a loaf, wherein, upon cooking of the composition, the at least two volatile compounds are generated in substantially higher amounts than upon cooking of the composition lacking the meat replica matrix. |
| <b>Claim 27</b>                                                                                                                                                                                                                                                                                                                                                                                                           |

|                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                             |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>27[pre]</b>                                                                                                                                                                                                                                                                                      | A method for making a meat replica matrix having a beef-like aroma,                                                                                                                         |
| <b>27[a]</b>                                                                                                                                                                                                                                                                                        | wherein the meat replica matrix comprises one or more plant proteins,                                                                                                                       |
| <b>27[b]</b>                                                                                                                                                                                                                                                                                        | a sugar selected from glucose, ribose, sucrose, fructose, xylose, maltodextrin, and combinations thereof, and at least one sulfur compound selected from methionine, cysteine and thiamine, |
| <b>27[c]</b>                                                                                                                                                                                                                                                                                        | the method comprising incorporating 0.01%-5% (by weight of the meat replica matrix) of a non-animal heme-containing protein into the meat replica matrix,                                   |
| <b>27[d]</b>                                                                                                                                                                                                                                                                                        | wherein, upon cooking of the meat replica matrix, at least two volatile compounds are generated that are associated with a beef-like aroma.                                                 |
| <b>Claim 29</b>                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                             |
| The method of claim 27, wherein the non-animal heme-containing protein has a UV-VIS spectrum that is substantially similar to that of myoglobin from an animal.                                                                                                                                     |                                                                                                                                                                                             |
| <b>Claim 30</b>                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                             |
| The method of claim 27, wherein the heme-containing protein is selected from the group consisting of a leghemoglobin, a flavohemoglobin, Hell's gate globin I, an erythrocrucorin, a protoglobin, a cyanoglobin, a chlorocruorin, a truncated hemoglobin, a truncated 2/2 globin, and a hemoglobin. |                                                                                                                                                                                             |
| <b>Claim 31</b>                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                             |
| The method of claim 27, comprising incorporating 0.4%-1% (by weight of the meat replica matrix) of the non-animal heme-containing protein into the meat replica matrix.                                                                                                                             |                                                                                                                                                                                             |
| <b>Claim 32</b>                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                             |
| The method of claim 27, wherein the one or more plant proteins are selected from the group consisting of rubisco, pea proteins, lentil proteins, and other legume proteins.                                                                                                                         |                                                                                                                                                                                             |

**Claim 33**

The method of claim 27, wherein the meat replica matrix is comprised within a meat replica composition, wherein the composition is selected from taco filling, a casserole, a sauce, a topping, soup, stew, and a loaf, wherein, upon cooking of the composition, the at least two volatile compounds are generated in substantially higher amounts than upon cooking of the composition lacking the meat replica matrix.

## I. INTRODUCTION

Motif FoodWorks, Inc. (“Petitioner”) respectfully requests *inter partes* review of claims 1, 3–11, 13–14, 16–24, 26–27, and 29–33 (“Challenged Claims”) of U.S. Patent No. 10,039,306 (“’306 patent”) assigned to Impossible Foods Inc. (“Patent Owner” or “PO”).

## II. STATE OF THE ART

### A. Meat Replicas

“The majority of the population in most developed countries consume meat” obtained from conventional practices of animal husbandry and slaughter. EX1003§VIII.A.1, ¶¶108-109; EX1029, 350. Despite its popularity, POSITAs have associated meat with potential human and animal health concerns to environmental damage incurred from cultivating slaughter animals and their feedstuffs. EX1003§VIII.A.2-4, ¶¶110-116; EX1035, 149 (citing “concerns about product safety” and increasing importance of “ethical issue of animal welfare”); EX1036, 662S (producing “animal protein requires about 100 times more water than” producing same amount “of grain protein”).

To encourage the consumption of meat “replicas” and thereby mitigate these harms, the art taught mimicking meat’s natural properties—coloration, taste, aroma, and nutrition profile. EX1003¶¶117-118; EX1021, [0003] (“[T]here is ***a need for healthy...products having the sensory properties (e.g., appearance, flavor, and texture) characteristic of all beef patties.***”), [0100] (teaching “***nutrients added to***

*the...simulated meat...to create a product with a nutrient composition comparable to animal meat products.”).*<sup>1</sup>

## **B. Heme-Containing Proteins**

Heme-containing proteins (“heme-proteins”) contribute multiple properties characteristic of meat, including meat-like nutrition, flavor, and color. EX1003§VIII.B.

Meat’s myoglobin is an important dietary iron source. EX1003¶¶119-121; EX1029, 329 (“Meat is an important dietary source of...iron...[which] plays a major role...[in] myoglobin in muscle,” and “haem[sp:heme] iron [is] more readily absorbed and utilized by the body.”). Myoglobin is also known to provide meat’s natural coloration. EX1003¶¶122-125; EX1027, 64–65 (“Myoglobin is the predominant pigment in muscle...[and] may account for as much as 95% of the iron in beef skeletal muscle....”). Before 2013, levels of myoglobin in bovine skeletal muscle were known (EX1027, 64-65):

[T]he following values for myoglobin for fresh bovine skeletal muscle [are]: 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...but may reach 8 to 12 mg/g ...Lamb may vary from 3 to 8 mg/g, but old ewes and rams may reach...12 to 18 mg/g.

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<sup>1</sup> All emphases herein are added unless otherwise indicated.

Before 2013, heme-proteins were known to contribute meaty flavor. EX1003¶134; EX1013, 4:14–16 (“addition of blood/hemoglobin...improves the meat flavour”); *infra* §§VI.A.4, VIII.A.4. Iron, including heme iron and iron from “blood cell powder,” was also known to enhance the “rich” taste of savory foodstuffs, including meats. EX1022, [0023] (pork), [0026]–[0028], [0031]–[0033], [0057], [0059] (hamburger), [0062]–[0101] (heme iron has “body taste-improving effect” and “all the strength of ***aroma, flavor and taste was increased by the existence of Fe component*** [iron]” in foodstuffs).

Lipid oxidation, which heme-proteins can promote over time, also favorably contributes to meaty aroma upon cooking. EX1005§V & ¶71; EX1017, 419 (“[A]ldehydes, from lipid autoxidation, are major contributors to the volatile profile of cooked meats.”), 420 (“[***L***]***ipid oxidation products*** during the initial cooking of meat...***contribute to desirable aromas.***”).

Similar to their animal counterparts, plant heme-proteins were known to contain heme-iron and have red pigmentation, as well as similar nutritional benefits. EX1003¶¶128-130; EX1030, 79 (research in 1930s showed “red pigment isolated from soybean root nodules was a hemeprotein,” leghemoglobin); EX1019, 1521 (“[B]ioavailability of hemoglobin from soy root nodules similar to that of heme iron from animal sources...provide[s] a unique alternative fortificant...”).

Leghemoglobin was also known to have similar structure as myoglobin. EX1135, 133, 139; EX1133, 1032; EX1003¶127.

The art taught methods to manufacture and utilize heme-proteins while avoiding conventionally-sourced meat. Alternative sources of heme-protein (like other foodstuff proteins) included well-known genetic engineering techniques to manufacture heme-protein via recombinant expression. EX1003¶¶131-132; EX1007§VI.C; EX1137; EX1138 (recombinant whey protein); EX1014. Heme-proteins were extracted and purified from plants to fortify foodstuffs. EX1003¶¶133; EX1019, 1519.

### **C. Meaty Aroma/Flavor and Color**

Methods of generating meaty (including beef-like) aroma in foodstuffs were long known in the art. Meaty aroma, which accounts for 80% of meaty flavor, is created by a profile of volatile odorants. EX1005§V.A, ¶¶27-32; EX1024, Table 1 (“Volatile Components of Natural Beef Aroma”); EX1026. Aroma is complex: hundreds of volatile compounds underlie what consumers perceive as “beef-like” aroma—some more significantly than others—and many of these volatiles are found in other foods’ aromas. 33-42; *infra* §XIV.A.1.

Many meaty aroma-associated volatiles are generated by heat-reacting certain types of precursor molecules—sugars and sulfur-containing compounds—via the “Maillard” chemical reaction. EX1005§V.B; EX1017. The “important role played

by cysteine and ribose in meat flavour formation...led to the classic patent...(1960)...involv[ing] the formation of a meat-like flavour by heating a mixture of these compounds” (EX1017, 416), and the food flavor industry developed this technology for decades. EX1005¶¶54-55.

Heating-reacting sugars and sulfur-containing compounds, like heat-denaturation of myoglobin, also leads to meat’s natural “browning.” EX1003¶125; EX1094, 82 (“[H]eat-induced Mb[myoglobin] denaturation is responsible for the dull-brown color of cooked meat.”), EX1028, 65.

#### **D. Person of Ordinary Skill in the Art (POSITA)**

The ’306 patent is directed to the art of food science and recombinant protein expression. A POSITA would have (i) a Bachelor of Science degree in food sciences, biology, chemistry, microbiology, or a related discipline, and (ii) a Master’s 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. EX1003¶¶34-36; EX1005¶¶82-83; EX1007¶39.

#### **E. The ’306 Patent**

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

Relevant to the Challenged Claims, the patent discloses exemplary experiments involving leghemoglobin and/or aroma. Example 33 discloses addition of “[f]lavor precursors”—various sugars and amino acids—“along with 1% Leghemoglobin” to replica products. EX1001, 84:9–31 & Table 8. Table 9, reproduced below, discloses sensory score(s) of replicas compared to beef (e.g., “Flavor: Beefy”).

| TABLE 9                                                                                          |       |          |     |     |     |
|--------------------------------------------------------------------------------------------------|-------|----------|-----|-----|-----|
| The sensory score determined by the sensory panel for the replica burgers and 80:20 beef sample. |       |          |     |     |     |
|                                                                                                  |       | Sample # |     |     |     |
|                                                                                                  |       | Beef     | 767 | 804 | 929 |
| Flavor Quality                                                                                   | mean  | 7.0      | 3.8 | 3.2 | 4.3 |
|                                                                                                  | STDEV | 0.0      | 1.3 | 1.0 | 1.2 |
| Flavor Intensity                                                                                 | mean  | 4.3      | 4.2 | 4.3 | 4.3 |
|                                                                                                  | STDEV | 0.8      | 1.2 | 1.4 | 1.2 |
| Flavor: Beefy                                                                                    | mean  | 5.8      | 3.3 | 2.3 | 4.2 |
|                                                                                                  | STDEV | 1.0      | 1.2 | 0.8 | 1.2 |
| Flavor: bloody/Metallic                                                                          | mean  | 4.5      | 2.0 | 2.2 | 3.2 |
|                                                                                                  | STDEV | 1.2      | 1.0 | 0.9 | 1.4 |
| Flavor: Savory                                                                                   | mean  | 3.3      | 3.8 | 3.7 | 4.2 |
|                                                                                                  | STDEV | 1.2      | 1.2 | 1.2 | 1.8 |
| Off Flavors:<br>chemical/oxidized/beany                                                          | mean  | 1.5      | 2.3 | 3.5 | 2.7 |
|                                                                                                  | STDEV | 0.8      | 1.2 | 1.8 | 1.0 |

Example 17 provides that “[a]dding recombinant leghemoglobin or myoglobin *to chicken* resulted in an increased beef aroma and flavor.” EX1001, 74:27-29. Example 16 discloses adjusting ingredient particle size in order “to control aroma generation,” as factors such as “tissue unit” size and mixing “had profound effects on the generation of aromatic compounds upon cooking.” EX1001, 72:28-31.

## **F. Prosecution History**

The '306 patent issued from U.S. Application No. 14/796,970 (“’970 application”), which was filed July 10, 2015. The '306 patent is a continuation of International Application No. PCT/US2014/011361, filed on January 13, 2014, which is a continuation of U.S. Application No. 13/941,211, filed July 12, 2013. The '970 application purports to claim priority to U.S. Provisional Nos. 61/908,634 (filed November 25, 2013) and 61/751,816, (filed January 11, 2013).

The '306 patent application went through four substantive rejections. After originally-filed claims reciting “an heterologous heme-containing protein” were rejected, PO amended the claims to recite “a heme-containing protein from a non-animal source.” EX1148, 1757.

The Examiner rejected the claims in a final office action, relying on an Espeleta-Vega embodiment comprising both plant protein and beef meat/flavorants, and the combination of Hseih (teaching a structured plant protein product) and Proulx (teaching fortifying foods with iron-containing soybean leghemoglobin). EX1148, 1840-44. PO “prepared samples” of a product “for tasting” but failed to persuade the Examiner. EX1148, 1847.

PO sought to continue prosecution by, *inter alia*, amending its claims again to recite “a meat replica that contains no animal products” and adding 0.01–5% of an “isolated” heme-containing protein (unlimited as to source). EX1148, 1874-77. PO

argued the claims were non-obvious because iron-supplementation of meat analogs was not an art-recognized problem, and that the art did not teach imparting beef flavor/aroma. EX1148, 1884.

The Examiner disagreed, again citing Hsieh/Proulx, reasoning that Hsieh disclosed meat flavorants and that Proulx taught the concept and general motivation to use “plant hemoglobin” as a dietary iron source. EX1148, 1944-56. The Examiner noted that PO had “not established that it is unexpected for heme-containing proteins to contribute to beef-like flavor.” EX1148, 1955. PO responded by largely reiterating prior arguments and asserting that iron’s organoleptic properties were “unpredictable, if not...likely negative” due to off-flavors. EX1148, 2073. The Examiner remained unpersuaded, again citing Hsieh/Proulx. EX1148, 2125-34.

PO ultimately amended its claims to recite—*for the first time*—the sugar and sulfur compounds recited in the issued claims. PO also argued, *inter alia*, that heme-protein’s inclusion yielded “novel” volatiles and a “unexpected”/“surprising” aroma “that more accurately mimics the aroma of beef.” EX1148, 2717. In support, PO submitted declarations from its employees and paid consultants. EX1148, 2717-21.

In allowing the claims, the Examiner reiterated the motivation to combine leghemoglobin in structured plant protein products, and that Maillard reaction precursors play “a substantial role in flavor generation” of meat. EX1148, 3267-68.

But she found PO “demonstrated” the claimed combination(s) of heme-protein, sugars, and sulfur compounds “produces *novel* (i.e., *not produced in the absence of heme-containing protein*) volatile compounds associated with a meaty aroma...” *Id.*, 3268. The claims were also amended to delete that the meat replica matrix “contains no animal products”—thus, the matrix does *not* exclude animal products—and instead add “non-animal” to modify “heme-containing protein.” EX1148, 3264.

### III. CLAIM CONSTRUCTION

#### A. Preamble

The Challenged Claims’ preamble (all claims) should not be found limiting.

“Generally, a preamble is not limiting.” *Summit 6, LLC v. Samsung Elecs. Co.*, 802 F.3d 1283, 1292 (Fed. Cir. 2015). The preamble is not limiting if the patentee “defines a structurally complete invention in the claim body and uses the preamble only to state a purpose or intended use for the invention.” *Catalina Mktg. Int’l, Inc. v. Coolsavings.com, Inc.*, 289 F.3d 801, 808 (Fed. Cir. 2002). This general rule has several exceptions; e.g., if a preamble recites “additional structure or steps underscored as important by the specification,” is “essential to understand limitations or terms in the claim body,” or provides necessary structure absent from the claim body.

No exceptions to the general rule exist here. As a POSITA would recognize, the claims’ body defines a structurally-complete invention. EX1003¶¶151-153. The

claims recite the combination of ingredients that generate beef-like aroma-associated volatiles, and the cooking thereof. The preamble only states a purpose or intended use for the invention—namely, achieving “beef-like” aroma. EX1003¶154.

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

Claim language without any bearing on the claimed methods should be non-limiting when it merely expresses a purpose for or intended result of the claimed method. *In re: Copaxone Consol. Cases*, 906 F.3d 1013, 1023 (Fed. Cir. 2018); *Bristol-Myers Squibb Co. v. Ben Venue Labs., Inc.*, 246 F.3d 1368, 1375 (Fed. Cir. 2001).

This term (in claim 1 and claims dependent therefrom) should not be limiting. The claims recite specific steps that achieve this aroma—e.g., sugars and sulfur compounds, which are Maillard precursors—in the claimed meat replica matrix, and the cooking thereof. The resulting “beef-like” aroma is merely the purpose and intended result of the steps of cooking Maillard precursors in that matrix. EX1003 ¶¶155-156.

If limiting, as taught in Mottram and explained by Dr. McGorin, cooking Maillard precursors (e.g., ribose and cysteine) naturally produces such compounds, including volatile compounds characteristic of beef-like aroma such as the character-impact compounds MFT and MFT-MFT. EX1005¶112; EX1017. As a POSITA

would recognize, the generation of these volatiles naturally imparts a “beef-like aroma” (an undefined term) to the claimed meat replica matrix. EX1003 ¶157.

**C. “non-animal”**

All claims recite a “non-animal” heme-containing protein. In parallel litigation, PO asserts that “no animal products” covers bovine myoglobin, which is native to an animal (*Bos taurus* (cow)), even when produced in engineered yeast. EX1116 (SAC), ¶¶32-36. If the Board adopts PO’s infringement interpretation advanced in the parallel litigation, Grounds relying on Crane are unaffected as they map “non-animal heme-containing protein” to bovine hemoglobin produced recombinantly. If PO’s interpretation is not adopted, these Grounds are unaffected because they alternatively map “non-animal heme-containing protein” to leghemoglobin, a heme-containing protein native to plants. EX1003 ¶¶158-159.

**D. “matrix”**

The ’306 patent does not define the term “matrix” (all claims). It is not necessary to construe the term “matrix” as, per its ordinary and customary meaning, a POSITA would understand it refers to the components of the meat replica. EX1003¶¶160-161; EX1001, 25:28-29 (“fibers that can form a matrix”), 34:44-47 (“protein/fat matrix”), 36:20-22 (“matrix of proteins and lecithin”).

#### IV. STATEMENT OF RELIEF REQUESTED

##### A. Identification of Challenge (37 C.F.R. §42.104(b)(1))

Petitioner requests *inter partes* review and cancellation of '306 patent claims 1, 3–11, 13–4, 16–24, 26–27, and 29–33.

##### B. Grounds of Challenge (37 C.F.R. §42.104(b)(2))

| No. | Claims                                        | Grounds for Challenge                     |
|-----|-----------------------------------------------|-------------------------------------------|
| 1   | 1, 3–9, 11, 13–14, 16–21, 23–24, 26–27, 29–33 | §103: Conrad, Mottram, Crane              |
| 2   |                                               | §103: Conrad, Mottram, Proulx             |
| 3   |                                               | §103: Rovaart, Conrad, Crane              |
| 4   |                                               | §103: Rovaart, Conrad, Proulx             |
| 5   | 7–8, 19–20                                    | §103: Rovaart, Conrad, Crane/Proulx, Cho  |
| 6   | 7–8, 19–20                                    | §103: Conrad, Mottram, Crane/Proulx, Cho  |
| 7   | 9–10, 21–22, 32                               | §103: Conrad, Mottram, Crane/Proulx, Boye |
| 8   | 9–10, 21–22, 32                               | §103: Rovaart, Conrad, Crane/Proulx, Boye |

#### V. SUMMARY OF PRIOR ART

##### A. Boye (EX1016)

Boye published on March 2, 2010 and is prior art under pre-AIA 35 U.S.C. §102(b). EX1009¶¶48-55. Boye teaches that “pulses,” such as peas, “are an

important source of food proteins,” and, given “growing global food security challenges and protein malnutrition,” pulses “may offer a promising alternative source for nutritional and functional proteins.” EX1016, Abstract; EX1003¶¶136-137.

**B. Cho (EX1140)**

Cho published on January 10, 2008 and is prior art under pre-AIA §102(b). Cho teaches “processes for producing the bland tasting [non-objectionable] soy protein isolates,” which “have very low levels of fat and volatile compounds that cause off-flavors in soy and are particularly suited for application in any number of food and drink products that incorporate soy proteins.” EX1140, Abstract; EX1003¶138.

**C. Conrad (EX1013)**

Conrad issued on April 4, 1989 and is prior art under pre-AIA §102(b). Conrad teaches “a meat replacement product” to which “a blood hemoglobin fraction can be added” “of up to 10% by weight” to provide “advantageous[.]...meat colour” and “desired taste improvement as it improves the meat flavour of the final product.” EX1003¶¶141-142; EX1013, Abstract; 1:56-61; 4:5-16.

**D. Crane (EX1014)**

Crane published on November 24, 2011 and is prior art under pre-AIA 35 U.S.C. §102(b). Crane teaches “methods of producing recombinant functional

heme-binding proteins with complete heme incorporation and purified preparations” thereof. EX1003¶¶139-140; EX1014, Abstract.

**E. Mottram (EX1017)**

Mottram published on August 17, 1998 and is prior art under pre-AIA 35 U.S.C. §102(b). EX1009¶¶56-63. Mottram teaches “[t]he characteristic flavour of cooked meat derives from thermally induced reactions...principally the Maillard reaction...” and that “important flavour compounds produced in the Maillard reaction provid[e] savoury, meaty, roast...flavours.” EX1003¶¶143-144; EX1017, Abstract.

**F. Proulx (EX1019)**

Proulx published on January 31, 2006 and is prior art under pre-AIA 35 U.S.C. §102(b); EX1009¶¶64-65. Proulx teaches that heme-containing proteins from plant sources, like leghemoglobin, are “can provide highly bioavailable iron as a food fortificant.” EX1003¶¶145-147; EX1019, Abstract.

**G. Rovaart (EX1125)**

Rovaart issued on December 30, 1975, and is prior art under pre-AIA 35 U.S.C. §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, Abstract; EX1003¶¶148-149.

**H. Cited Non-Patent References Are Printed Publications Publicly Available Before the Priority Date of the Challenged Claims**

Boye, Mottram, and Proulx are printed publication prior art. As set forth in EX1009, Boye, Mottram, and Proulx were disseminated or otherwise made available, including being cataloged and indexed by a library, such that a person interested in and ordinarily skilled in the relevant subject matter could locate them through the exercise of ordinary diligence on or about March 2, 2010, August 17, 1998, and January 31, 2006, respectively. Indeed, Dr. Tarté opines that Boye, Mottram, and Proulx were published by highly reputable scientific journals and leading publishers in the field of food science, and were available to POSITAs exercising reasonable diligence before 2013. EX1003¶¶136, 143, 145.

Additionally, Ms. Hall-Ellis testified that, as indicated by MARC and other records, the corresponding publication was publicly available on or around that same date through libraries with access to the OCLC bibliographic database or through an individual library. *Supra* §V.A, D-E. As testified by Ms. Hall-Ellis, EX1016, EX1017, and EX1019 are authentic copies that would have been available to a POSITA as of the dates cited above, respectively. *Supra* §V.A, D-E. Nor did PO argue in prosecution of the '306 patent that any of these references (*e.g.*, Proulx) were not prior art.

## VI. GROUND 1: CONRAD, MOTTRAM, CRANE

Claims 1, 3–9, 11, 13–14, 16–21, 23–24, 26–27, and 29–33 of the '306 patent are obvious over Conrad in view of Mottram and Crane. EX1003§XII.

Each is analogous art to the '306 patent, which relates to the desirability of making “improved” meat replica products that, due to “improved” meat-like properties, would appeal to a broader consumer base and motivate a shift away from the consumption of conventionally-sourced meat. EX1003¶¶163-166.

**Conrad**, which relates to a “Bran-Gluten Meat Replacement Product” (title), motivates a POSITA to pursue meat replicas. 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, 1:25-40. Conrad further 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, 1:25-40, Table 1 (teaching 14% “Bran-fiber” in “Wheat Meat” compared to 0% Bran-fiber in meat); EX1003¶¶167-169.

Conrad’s replicas comprise hemoglobin (heme-protein) from slaughtered-animal blood. EX1013, 1:56-61; 4:3-17. According to Conrad, “*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, 4:3-17; EX1003¶170.

Conrad’s meat replacement product (“grain meat”/“wheat meat”), which maps to the claimed “meat replica matrix,” is used to partially replace real meat in consumables (*infra*); thus, Conrad’s consumable embodiments (e.g., sausage, meatballs) also contain real meat. As explained further below with respect to claims 1, 14, and 27 limitation [b], 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). EX1003¶¶171-172.

Conrad’s “meat replica matrix” is *itself* meat-free. EX1013, Table 1 (“wheat meat” recipe); EX1003¶¶173. The ’306 patent claims do not exclude meat, however, and, indeed, its claims were amended to delete the limitation that the meat replica matrix “contains no animal products” and instead add the term “non-animal” to modify *only* the “heme-containing protein” limitation. EX1147, 3264.

**Mottram** teaches meat flavor science and its application in industrial food production. EX1003¶¶174-176; EX1017, 415 (“[*D*]esirable characteristics of meat flavour have also been sought *in the production of simulated meat flavourings*

*which are of considerable importance in convenience and processed savoury foods.*”); *id.* at 416 (discussing industrial development of “‘reaction product’ meat flavorings”). Mottram teaches that, when cooked, sugars and sulfur-containing compounds generate meaty aroma-associated volatile compounds and thereby contribute meaty flavor. EX1017, 415 (“***The characteristic flavour of cooked meat derives from*** thermally induced reactions..., principally ***the Maillard reaction***....”).

**Crane** 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, Abstract, [0021], [0024], [0040], [0060]-[0062], [0085]. Such commercial applications include foodstuffs, as a POSITA would recognize recombinant technology’s usefulness for generating proteins for use in consumables. EX1003¶¶177-178; EX1007¶¶50-51.

#### A. Claims

1. **Claims 1[pre], 14[pre], 27[pre] (“A method for imparting a beef-like aroma to a meat replica matrix”; “A method for making a meat replica matrix having a beef-like aroma”)**

The preamble is not limiting. *Supra* §III.A. Regardless, **Conrad** teaches a meat replica matrix: “The present invention relates to ***meat replacement products***...” EX1013, 1:11-18, 1:21-40, 1:43-61, Table 1 (“Wheat meat” recipe); Table 2 (“Wheat meat CH” recipe”), Example 2 (“Preparation of a sausage...”);

Example 3 (“Preparation of minced meat balls”); EX1003¶¶181-183. Conrad teaches multiple advantages of its meat replacement products (EX1013, 1:32-49):

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

Conrad teaches “grain meat,” e.g., “wheat meat” that is structured along with other components—including conventionally-sourced meat—into products designed to resemble fully-meat products (e.g., sausage in Example 2 and meatballs in Example 3). EX1013, 1:43-49; Tables 1 & 2. EX1003¶¶184-185. This “grain meat” “can replace meat in minced meat products.” EX1013, 1:42-49.

As explained below for limitations [b]/[d], a POSITA would be motivated to combine Mottram with Conrad with a reasonable expectation of success, as Mottram teaches that incorporating the claimed sugars and sulfur-containing compounds into the meat replica matrix produces volatile compounds associated with beef-like aroma upon cooking. EX1003¶186.

**2. Claims 1[a], 14[a], 27[a] (“wherein the meat replica matrix comprises one or more plant proteins”)**

**Conrad** discloses a meat replica matrix with a “grain meat”—preferably “wheat meat”—replica used to replace at least some conventionally-sourced meat in foodstuffs, and methods and advantages of making this product. EX1013, 1:32-49; EX1003¶¶187-188.

Conrad's meat replica comprises, for example, wheat (EX1013, 1:50-55; *see also id.*, 2:1-8 ("The grain meat...can be made of corn (maize), barley, oat, and rye as well..."). Wheat is a plant, as are the other grains (cereals). EX1001, 18:34-58. In particular, Conrad discloses that its meat replacement products comprise the grain protein "gluten" (EX1013, 1:50-55):

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

3. **Claims 1[b], 14[b], 27[b] ("sugar selected from . . . ribose . . . and at least one sulfur compound selected from . . . cysteine . . .")**

As a POSITA would recognize, the claimed sugars and sulfur compounds are "Maillard reaction" precursors, which have long been known to produce volatile compounds associated with meaty aromas when heated. EX1003¶¶189-190; EX1005§V.B; *see also* limitation [d] *infra*.

**Mottram** teaches that Maillard reactions between amino compounds and reducing sugars are "one of the most important routes to flavour compounds in cooked foods, including meat." EX1017, 416, 417, 422; EX1003¶¶190-191. For example, Mottram describes the results of flavor studies which found that ***ribose***, which Mottram describes as "one of the main sugars" in muscle, and ***cysteine*** (an

amino acid) play “an important role ... in meat flavour formation” when mixtures of the two compounds were heated. EX1017, 416. Other flavor precursors include “free sugars,” “free amino acids,” and “*thiamine*.” *Id.*

These precursors have long been used in the art for the purpose of providing meaty flavor. EX1005¶¶54-55. As taught in Mottram, since the “classic patent” on this technology six decades ago, the industry has sought to patent “reaction product” meat flavorings based on these precursors. EX1017, 416. As a POSITA would understand, such meat flavorings could be used to enhance the meaty flavors and aromas of a variety of foodstuffs. EX1003¶192.

In light of the art’s long recognition of Maillard reaction precursors’ role in creating meaty flavors/aromas, a POSITA would be generally motivated to include Mottram’s Maillard precursors in a meat replica such as Conrad’s “grain/wheat meat,” with a reasonable expectation of success. EX1003¶193. Conrad’s meat replacements are designed to replace at least part of real meat in a foodstuff, and a POSITA would be motivated to improve the replacement’s meaty flavor in order to enhance its “meat-like” qualities and thereby appeal to consumers by better creating the sensory experience of consuming real meat. EX1003¶194.

In particular, a POSITA would be motivated to include the sugar *ribose* and the sulfur compound *cysteine*, which Mottram teaches are naturally present in meat and are “particularly important for” generating “the characteristic aroma of meat”

when meat is cooked. EX1017, 417; EX1003¶¶195; EX1005§V.B (discussing other sugar/sulfur compound combinations generating beef-like aroma).

The Maillard reaction is mainly responsible for the large number of heterocyclic compounds which have been found in the volatiles of cooked meat and are responsible for savoury, roast and boiled flavours.

***Pentoses, in particular ribose from meat ribonucleotides, and the sulfur-containing amino acid, cysteine, are important precursors for these reactions in meat.*** Furanthiols and furan sulfides and disulfides are very important flavour compounds, with exceptionally low odour threshold values, which are responsible for characteristic meaty aromas.

EX1017, 422.

A POSITA would also recognize benefits of combining Mottram's sugar (e.g., ribose) and sulfur compound (e.g., cysteine) ingredients with Conrad's "wheat meat" meat replica matrix because Conrad's matrix is depleted of sugars and other components during its manufacture, such that Conrad's replica might undesirably lack meaty, beef-like aroma. EX1013, 2:1-46; EX1003¶¶196.

Specifically, **Conrad** discloses that, in manufacturing its "wheat meat," sugars are removed when "[t]he grain meat...is ***separated into two main components,***"—a "solid phase--***grain meat***"—as well as "a suspended aqueous

phase” which comprises “***starch granules containing*** most of the water-soluble components of the grain such as soluble proteins, salts, and ***sugars***.” EX1013, 2:1-8; *see also id.* 2:25-28 (“The production of wheat meat encompasses...mechanical treatment and separation of fractions.”); Example 1; EX1003¶197.

Because a POSITA would recognize that Maillard precursors (e.g., sugars) are depleted from Conrad’s products during preparation of the “grain meat” fraction, a POSITA would be motivated to add **Mottram’s** precursors (e.g., cysteine/ribose) to Conrad’s meat replicas in order to increase generation of volatile compounds associated with “beef-like” aroma. EX1003¶198. A POSITA would reasonably expect success in doing so because, as explained below regarding limitation [d], the art long taught that heating these precursors naturally produces volatiles that have been associated with meaty/beefy aroma, such as the character-impact compounds MFT and MFT-MFT. EX1005§VII.

**4. Claims 1[c], 14[c], 27[c] (claim 1[c]: “the method comprising adding 0.01%-5% (by weight of the meat replica matrix) of a non-animal heme-containing protein to the meat replica matrix”)**

**Conrad** teaches a POSITA that adding up to 5% heme-protein would contribute meaty flavor and coloration in addition to other benefits. EX1003¶¶199-200.

Conrad discloses “grain meat”/“wheat meat” meat replica matrices that advantageously contain heme-protein (hemoglobin). EX1013, 1:56-61; 4:3-17. 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.” EX1013, 4:3-17. *Second*, 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; EX1003¶201.

Conrad teaches levels of heme-protein in its meat replicas that achieve these desirable meat-like properties. Conrad discloses utilizing the “hemoglobin part of whole blood” in its grain-based “meat” (EX1013, 1:56-61, 4:5-10), which a POSITA would understand to refer to red blood cells that comprise hemoglobin protein. EX1003¶¶202-204. Consistent with this understanding, Conrad teaches that “the dry substance contents [of the “hemoglobin part”] are 33% by weight,” which a POSITA would understand to be the non-water components of the cells, such as proteins or lipids. EX1013, 4:5-10; EX1003¶205. Conrad further teaches that “the protein content” of this dry fraction—which a POSITA would understand to primarily comprise the heme-protein hemoglobin—“is about 90% by weight.” EX1013, 4:5-10; EX1003¶206; EX1139, 584 (“[H]emoglobin...accounts for 97% of [a red blood] cell’s dry weight”). For example, Conrad teaches that 30 grams of the 100-gram “Hemoglobin” component of its Table 2 “Wheat Meat CH” embodiment are “protein”—i.e., “Hemoglobin” is only 30% protein—which equates

to approximately 90% heme-protein within 33% of a 100-gram “hemoglobin part.”

Thus, the 2100-gram Table 2 embodiment comprises **1.43%** heme-protein.

EX1003¶¶207-209.

Conrad teaches other embodiments with higher heme-protein concentrations. For example, Conrad teaches adding the “hemoglobin part” “up to 10% by weight *dry weight* of the gluten-bran product *dry weight*.” EX1013, 1:56-61. This teaching can be applied to Conrad’s Table 1 “wheat meat” embodiment, which contains 65%/35% water/non-water (dry) components, respectively. E.g., the “dry” portion of the “hemoglobin part” contributes 10% of the embodiment’s 35% dry components—i.e., 3.5%—of which 90% is heme-protein, representing **3.15%** of the total embodiment. Conrad also teaches that adding “up to 15% by weight of...preferably the hemoglobin part” provides desirable meaty color (EX1013, 4:5-10), which, following the same principles, represents **4.46%** heme-protein in the total replica. EX1003¶¶210-216.

Conrad does not identify a lower limit of heme-protein to use. EX1013, 1:56-61, 4:5-10 (reciting “**up to**” 10% or 15% of “hemoglobin part”); EX1003¶217. A POSITA would understand that incorporating lower levels of heme-protein could replicate proportions of heme-protein naturally present in various kinds of meat, which could be desirable to enhance the “meat-like” characteristics of Conrad’s meat replacements depending on the type of meat being replicated and the levels of heme-

protein that naturally occur in that type of meat. For example, percentages of myoglobin differ across meats. EX1027, 65 (teaching, e.g., “veal, 1 to 3 mg/g [0.1-0.3%]; beef, 4 to 10 mg/g [0.4-1.0%]; and old beef animals, 16 to 20 mg/g [1.6-2.0%]. Pork contains 1 to 3 mg/g for young animals...[0.1-0.3%]”). For example, to replace meats that naturally contain lower levels of myoglobin (e.g., veal or young pork), a POSITA would be motivated to incorporate heme-protein in Conrad’s meat replacements at levels approaching the lower bound of the claimed heme-protein range (**0.01%-5%**); EX1003¶¶218-220.

Thus, **Conrad** discloses or motivates adding between 0.01%-5% heme-protein to meat replicas in order to achieve desirable meat-like properties. EX1003¶¶221. The range taught in Conrad’s embodiments—e.g., “up to 15%” of the hemoglobin part, or approximately 4.5% heme-protein—almost completely overlaps with the claimed range, and therefore renders it obvious. *Almirall, LLC v. Amneal Pharms. LLC*, 28 F.4th 265, 272 (Fed. Cir. 2022) (“A *prima facie* case of obviousness typically exists when the ranges of a claimed composition overlap the ranges disclosed in the prior art.”).

#### (a) Motivation to Combine with Crane

A POSITA would be motivated to substitute Conrad’s blood-sourced hemoglobin with Crane’s recombinantly-produced heme-proteins, with a reasonable expectation of success. EX1003XII.A.4(a), ¶¶222-236.

**Crane** teaches methods of producing various heme-proteins, including leghemoglobin, using recombinant technology. EX1014, [0021] (“The...heme-binding proteins...encompassed by the methods...include...e.g., hemoglobin, myoglobin...leghemoglobin...”). A POSITA would be motivated to utilize hemoglobin or leghemoglobin obtained using Crane’s methods in Conrad’s “grain/wheat meat,” as a POSITA would expect doing so to contribute (1) **desirable meat-like coloration**, (2) **desirable aroma/flavor**, and (3) **desirable meat-like nutrition** to Conrad’s foodstuffs. EX1003¶¶229-232.

Color: A POSITA would understand that heme-proteins (e.g., myoglobin) are “predominant” red pigments in animal muscle and denature when heated, causing meat’s browning. EX1027, 64; EX1094, 82 (denaturation leads to “dull-brown” meat color).) As **Crane**’s recombinant hemoglobin is the same as those heme-proteins found in animal muscle, a POSITA would expect it to contribute to color in the same manner as **Conrad**’s hemoglobin. Likewise, leghemoglobin is structurally similar to myoglobin/hemoglobin and provides meat-like color to plants. EX1030, 79 (leghemoglobin is “red pigment isolated from soybean root nodules”), EX1135, 133 (“Leghaemoglobins are plant haemoproteins which resemble animal myoglobins...”); EX1133, 1032 (“[T]ertiary folding patterns of...soybean Lb are very similar to those of mammalian myoglobins, and the  $\alpha$  and  $\beta$  subunits of human hemoglobin...”). A POSITA would therefore expect Crane’s recombinant

leghemoglobin to achieve similar meat-like coloration in Conrad's grain meat as myoglobin/hemoglobin achieves in meat. EX1003¶¶233-234.

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. EX1003¶235; EX1135, 133; EX1133, 1032.

Nutrition: Meat is an important dietary source of iron for many consumers and "haem[sp:heme] iron [is] more readily absorbed and utilised by the body" than other forms. EX1029, 329. E.g., myoglobin provides 95% of the iron in beef muscle. EX1027, 64-65. Similarly, **Crane**'s heme-proteins, such as recombinant hemoglobin or leghemoglobin, are "fully incorporated" with heme iron and would be expected to achieve the same dietary benefit. EX1014, [0080], [0084]-[0085]; EX1019 (discussed *infra* Ground 2); EX1003¶236.

A POSITA would be motivated to replace **Conrad**'s blood-sourced hemoglobin with **Crane**'s recombinantly-produced heme-proteins. First, a POSITA would be aware that obtaining blood from slaughtered animals incurs the same environmental consequences, expenses, and other ramifications as cultivating animals for meat, as well as the widespread desire in the art to reduce consumption

of conventionally-sourced meat and animal products. EX1003¶¶222-223. Thus, a POSITA would be motivated to replace Conrad's conventionally-obtained hemoglobin with heme-proteins obtained from alternative sources. EX1003¶223. **Conrad** teaches or suggests this motivation, as Conrad teaches utilizing meat replacement products in place of "animal meat." EX1013, 1:25-40. **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."); EX1003¶¶224-225.

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

recombinantly overexpressed heme proteins.”); [0043] (“***fungal*** [expression] ***systems are more efficient and economical...***”); EX1003¶¶226-227.

Third, **Crane**’s heme-proteins can be purified, for example using cleavable “tags,” which a POSITA would understand is generally desirable for a commercial application such as Conrad’s “grain meat,” to achieve standardized ingredients and promote product stability. EX1014, [0024], [0060]-[0062]; [0074] (disclosing His-tagged purification of heme-protein). EX1003¶228. Indeed, Crane teaches that “[p]urified preparations of heme-binding proteins...have a variety of therapeutic, research, and commercial utilities”—which a POSITA would understand to include use in foodstuffs. EX1014, [0061]-[0062]; EX1003¶229; EX1007¶¶50-51.

Thus, a POSITA would be motivated to utilize Crane’s heme-proteins instead of slaughtered-animal blood in Conrad’s products, with a reasonable expectation of success. EX1003¶228.

**5. Claims 1[d], 14[d], 27[d] (“wherein, upon cooking of the meat replica matrix, at least two volatile compounds are generated that are associated with a beef-like aroma, [thereby imparting a beef-like aroma to the meat replica matrix]”)**

**Conrad** teaches that its meat replicas should be cooked. EX1013, 5:35-50 (disclosing “comparative testing ***frying***” “wheat meat balls”). A POSITA would reasonably expect success in producing at least two volatile compounds associated

with beef-like aroma when frying Conrad's products (containing Mottram's sugar and sulfur compound precursors). EX1003¶¶237-239.

As disclosed in **Mottram** and well-known to a POSITA, the art long taught that when sugars and sulfur compounds are heated together, they produce many volatiles associated with meaty aromas, including meat's character-impact compounds. EX1005§§V.B & VIII (reviewing EX1017, EX1032–1034, EX1038, EX1041, EX1045, EX1099, EX1129); EX1003¶239. Mottram teaches, for example, that “[t]he characteristic flavour of cooked meat derives from thermally induced reactions...principally the Maillard reaction...leading to a wide range of products, which account for the large number of volatile compounds found in cooked meat.” EX1017, Abstract; *see also id.*, 417 (“This reaction is complex and provides a large number of compounds which contribute to flavour.”); EX1003¶¶239-240.

Of these volatiles, “[h]eterocyclic compounds...are important flavour compounds produced in the Maillard reaction providing savoury, meaty, roast and boiled flavours.” EX1017, Abstract. Like other prior art disclosures, Mottram discloses that the Maillard reaction produces compounds that are “major contributors” to beef-like aroma (for example, via heat-reacting ribose/cysteine) (*see also* EX1005¶112):

It has been known for some time that furans and thiophenes...possess strong meat-like aromas and exceptionally low odour threshold

values.... Gasser...identified *2-methyl-3-furanthiol*[MFT] and the corresponding disulfide, *bis-(2-methyl-3-furanyl) disulfide*[MFT-MFT], *as major contributors to the meaty aroma of cooked beef*.

EX1017, 418 (emphasis added); *see also id.* (“Evaluation...indicated *meaty characteristics for compounds containing 2-methyl-3-furanyl groups... [F]urans* with a thiol or sulfide group in the 3-position on the ring, *possessed meaty odours...*); 422 (“*Furanthiols and furan sulfides and disulfides* are very important flavour compounds...which are *responsible for characteristic meaty aromas.*”).

Only ordinary skill would be required to prepare and assemble the individual components—e.g., **Mottram**’s sugar and sulfur precursors, and **Crane**’s purified recombinant hemoglobin—into **Conrad**’s meat substitute product and heat to generate at least two volatile compounds associated with beef-like aroma. EX1003¶¶240-241; EX1005§VII.

Conrad teaches conventional methods of mixing and heating ingredients for its “grain meat” replicas. EX1013, 5:12-15 (“All raw materials are ground or cut together to a smooth paste...”). Conrad also teaches a method for manufacturing “wheat meat.” EX1013, Example 1; *see also* 5:12-13 (“All raw materials are ground or cut together to a smooth paste...”); EX1003¶242.

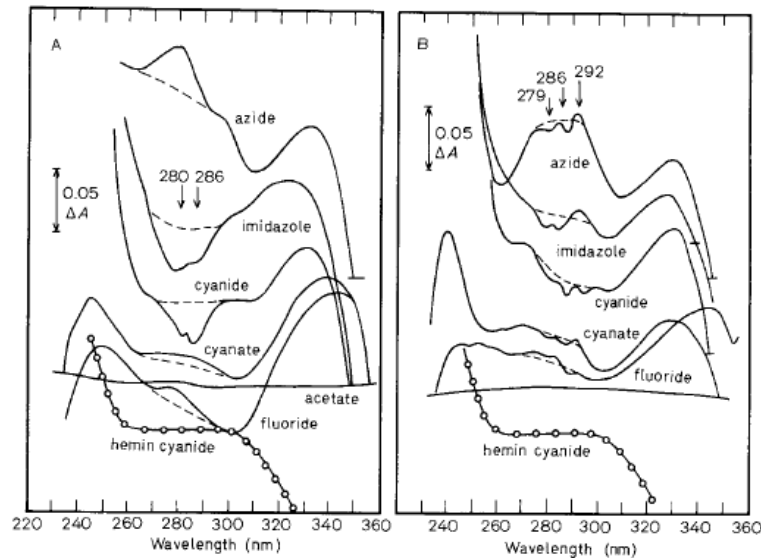
Moreover, a POSITA would reasonably expect success in imparting a beef-like aroma to Conrad’s meat replacement products because well-known Maillard

reaction chemistry taught that specific precursor compounds—cysteine/ribose—generate more than two volatiles associated with beef-like aroma when heated. EX1003¶¶243; EX1005§VII; EX1017, 415-19.

**6. Claims 3, 16, 29 (“The method of claim 1 [14, 27], wherein the non-animal heme-containing protein has a UV-VIS spectrum that is substantially similar to that of myoglobin from an animal.”)**

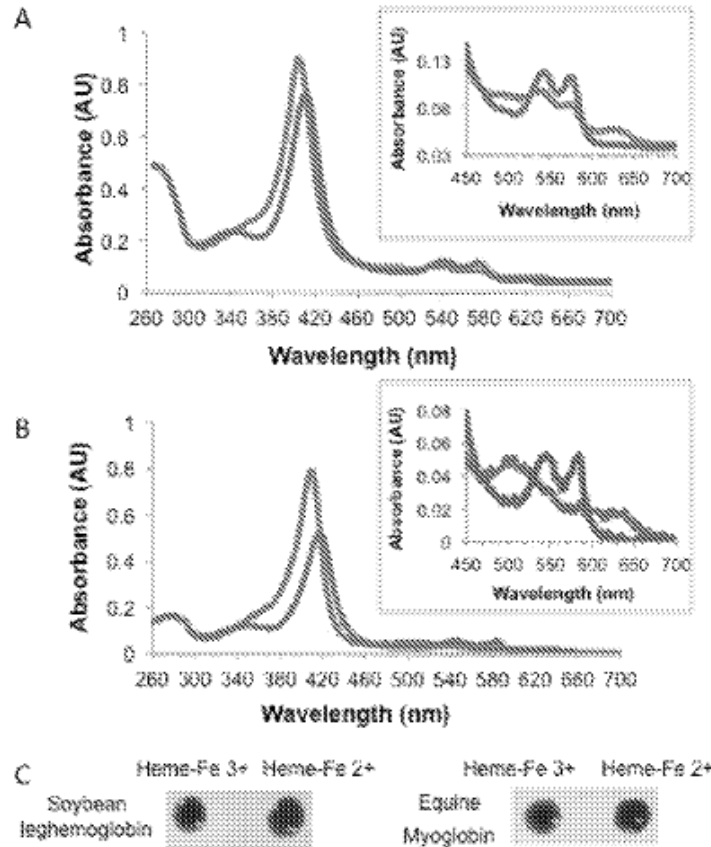
As explained above (claims 1, 14, 27), a POSITA would be motivated to use **Crane’s** recombinant leghemoglobin or myoglobin in **Conrad’s** “grain/wheat meat.” EX1003¶¶244-245. Crane’s recombinant myoglobin is the same *protein* as myoglobin “from an animal,” differently sourced. EX1003¶¶246.

The art taught that “[t]here is a high degree of structural homology between myoglobin and leghaemoglobin revealed by sequence alignments” and leghemoglobin “resemble[s] animal myoglobins with respect to their molecular weight, monomeric state” and other properties. EX1135, 133, 139, Figure 2 (below, showing spectral similarities of ligand-bound whale myoglobin (left) and soybean leghemoglobin (right)).



The three-dimensional structures of myoglobin and leghemoglobin are “very similar”—e.g., “[t]he tertiary folding patterns of lupin and soybean Lb[leghemoglobin] are very similar to those of mammalian myoglobins, and the  $\alpha$  and  $\beta$  subunits of human hemoglobin.” EX1133, 1032; EX1003¶¶246-247.

Indeed, as PO recognizes, leghemoglobin naturally “has a virtually identical absorbance spectrum and visual appearance to myoglobin from animal muscle.” EX1012, [00377]; EX1003¶248. PO demonstrated this natural property of leghemoglobin as reproduced below (EX1012, Fig. 5):



Accordingly, the non-animal heme-containing protein from Crane has a UV-VIS spectrum that is substantially similar to that of myoglobin from an animal. EX1003¶246.

**7. Claims 4, 17, 30 (“The method of claim 1 [14, 27], wherein the heme-containing protein is selected from the group consisting of a leghemoglobin, ... and a hemoglobin.”)**

As explained above (claims 1, 14, 27), a POSITA would be motivated to substitute **Conrad’s** conventionally-sourced hemoglobin with **Crane’s** leghemoglobin, with a reasonable expectation of success. Like hemoglobin obtained from slaughtered animal blood, leghemoglobin has a red, meat-like pigment. EX1030, 79; EX1003¶¶250-251.

A POSITA would also recognize that a variety of “non-animal” heme-proteins, such as plant hemoglobins, could be manufactured using Crane’s techniques and could also be used for this purpose. EX1030 (reviewing “six decades” of research on plant hemoglobins); EX1014, [0021] (“[C]lasses of heme-binding proteins that are encompassed by the methods of the present invention include...hemoglobin,....The recombinant heme-binding protein produced using the methods of the present invention can be prokaryotic or eukaryotic.”); EX1003¶¶252-253.

**8. Claims 5, 18, 31 (“The method of claim 1 [14, 27], comprising incorporating into the meat replica matrix 0.4%-1% (by weight of the meat replica matrix) of the non-animal heme-containing protein.”)**

As explained above (claims 1, 14, 27), **Conrad** discloses adding 0.01-5.0% of blood-sourced heme-protein to its “grain/wheat meat,” EX1013, 1:56-61, which a POSITA would be motivated to replace with **Crane’s** leghemoglobin. EX1003¶¶254-255. This range encompasses, and thus renders obvious, the claimed 0.4%-1% limitation. *Almirall*, 28 F.4th at 272.

Additionally, as discussed above, a POSITA would be motivated to incorporate heme-protein in Conrad’s meat replacements at levels naturally present in the type of meat being replicated. As beef naturally contains 0.4-1.0% myoglobin (EX1027, 65), a POSITA seeking to replicate that proportion of heme-protein in a

beef replica would be motivated to incorporate 0.4-1.0% “non-animal” heme-protein (e.g., leghemoglobin) in the beef replica at the claimed amount. EX1003¶¶257-258.

**9. Claims 6, 24 (“The method of claim 1 [14], wherein the non-animal heme-containing protein is purified.”)**

As explained above (claims 1, 14), a POSITA would be motivated to purify heme-proteins for use in foodstuffs and would reasonably expect success doing so, as **Crane** teaches methods of producing purified heme-protein preparations by separating heme-proteins from other components of Crane’s expression systems, e.g., via cleavable “tags” attached to the heme-protein when initially expressed. EX1014, [0060]-[0062]; *see also id.* [0074]-[0075] (“The...plasmid allows over-expression of [heme-protein] with a cleavable His-tag...GsNOS was expressed and purified....to >95% purity using size exclusion chromatography”); EX1003¶¶261-262.

**10. Claims 7, 19 (“The method of claim 1 [14], wherein at least one of the one or more plant proteins is isolated.”)**

As explained above (claims 1, 14), **Conrad** discloses isolating plant proteins from other plant components in the soybean source material, e.g., sugars and soluble proteins. EX1001, 17:33-51, 20:32-37. E.g., Conrad’s “grain meat” “comprises *the gluten protein fraction* and the bran fraction *from whole cereal grain* [a plant source],” EX1013, 1:50–52, which is “is prepared from the whole grain which after

crushing **is separated** into two main components...” EX1013, 2:1-6, 2:24-28, 2:66–3:2 (disclosing separation “by sieving on a sieve...”). EX1003¶¶263-266.

POSITAs would be motivated to isolate proteins for use in Conrad’s meat replicas and would reasonably expect success doing so given known isolation/purification techniques. EX1003¶¶267 & Ground 6 *infra* (discussing purifying “wheat germ oil” from Conrad’s products).

**11. Claims 8, 20 (“The method of claim 7 [19], wherein at least one of the one or more isolated plant proteins is purified.”)**

As explained above (claims 1, 14; also 7, 19), **Conrad** discloses separating (purifying) plant proteins from other plant components, as gluten is “purified” via separation from other components in the soybean. EX1001, 17:33-51, 20:35-37. A POSITA would be motivated to further purify isolated proteins for use in Conrad’s foodstuffs, as doing so would desirably eliminate components of the source material—*e.g.*, fats that might oxidize and contribute to off-flavors—with a reasonable expectation of success as techniques for doing so were well-known. EX1003¶¶268-271.

**12. Claims 9, 21, 32 (“The method of claim 1 [14, 27], wherein the one or more plant proteins are selected from the group consisting of rubisco, pea proteins, lentil proteins, and other legume proteins.”)**

As explained above (claims 1, 14, 27), **Conrad** teaches or suggests that legume proteins, *e.g.*, soybean proteins, can be used in its products. Conrad teaches,

for example, that “[i]t is also known to replace some of the animal meat tending to be somewhat expensive with *soybean meal which is a protein rich* vegetable product.” EX1013, 1:25-27; 18:34-48. A POSITA would reasonably expect that combining heme-protein with soybean protein would achieve the same desired meaty flavor/coloration benefits taught for Conrad’s “grain/wheat meat.” EX1003¶¶272-273.

**13. Claims 11, 23 (“The method of claim 1 [14], wherein the one or more plant proteins are present in the meat replica matrix in an amount of between 1% and 30% (by weight of the meat replica matrix).”)**

As explained above (claims 1, 14), Conrad provides an exemplary recipe for “wheat meat” containing 15% plant protein:

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

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

EX1013, 3:50-67, highlighting added.

Conrad teaches “adding thereto up to 15% by weight of blood.” EX1013, 4:3–10. A POSITA would recognize that this addition of heme-protein could proportionally dilute plant proteins down to 85% of the levels disclosed for Table 1’s “wheat meat”—i.e., to 12.75%—while remaining within the claimed range of 1–30%. EX1003¶¶274-276.

14. **Claims 13, 26, 33 (“The method of claim 1 [14, 27], wherein the meat replica matrix is comprised within a consumable product, wherein the consumable product is selected from taco filling, a casserole, a sauce, a topping, soup, stew, and a loaf, wherein, upon cooking of the consumable product, the at least two volatile compounds are generated in substantially higher amounts than upon cooking of the consumable product lacking the meat replica matrix.”)**

As shown *supra* claims 1, 14, 27, **Conrad** teaches or suggests uses for its meat replicas within consumable products—for example, a sausage replica sandwich “topping” as well as “meat balls.” EX1013, 4:51-52; Example 2 (“Preparation of sausage to be... used ***on top of*** a sandwich”); Example 3 (“Preparation of minced meat balls”).

A POSITA would understand these replicas could replace conventionally-sourced meat equivalents in various consumables/compositions. For example, Conrad’s “meatballs” could be utilized in spaghetti ***sauce*** (a ***topping*** for spaghetti). EX1003¶¶277-279.

These claims cover two forms of consumable products: (1) consumables/meat replica compositions containing a meat replica matrix, and (2)

consumables/compositions “lacking the replica matrix.” As taught or suggested in Conrad, an example of the former could be “meatballs” in spaghetti **sauce** (alternatively, a spaghetti **topping**). The latter consumable would be the sauce alone. EX1003¶280.

Cooking the former consumable (*e.g.*, **sauce** with **Conrad**’s “meatballs” containing **Mottram**’s Maillard precursors) would produce at least two volatile compounds associated with beef-like aroma. *Supra* limitations [b], [d] (claims 1,14,27). The latter consumable might lack Maillard precursors and not generate meaty aroma-associated volatiles when cooked. Regardless, a POSITA would expect that combining Conrad’s meat replica with the latter consumable would naturally produce “substantially higher” amounts of the claimed volatiles than if the replica were *not* included in the sauce. EX1003¶281-282.

Thus, a POSITA would understand that cooking the former consumable would produce “substantially higher” amounts of aroma-associated volatiles than cooking the latter—i.e., “the consumable product lacking the meat replica matrix.” EX1003¶283.

## VII. GROUND 2: CONRAD, MOTTRAM, PROULX

Claims 1, 3–9, 11, 13–14, 16–21, 23–24, 26–27, and 29–33 of the ’306 patent are obvious over Conrad in view of Mottram and Proulx. EX1003§XIII. **Proulx** is analogous art because, as recognized by the ’306 patent Examiner, Proulx provides

a motivation to fortify foodstuffs with heme iron. *E.g.*, EX1148, 1944-56. 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, 1518. Recognizing that “incorporation of animal-sourced heme iron is often unfeasible because of economic costs or because [of] cultural and religious barriers” (EX1019, 1521), Proulx teaches advantages of “use of plant hemoglobins for improving...human diet,” particularly leghemoglobin sourced from soybeans. EX1019, 1521; EX1003¶¶284-286.

#### **A. Claims**

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

Conrad and Mottram render these limitations obvious. *Supra* §VI; EX1003¶¶287-288.

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

**Proulx’s** plant-sourced leghemoglobin is the same leghemoglobin protein (e.g., amino acid sequence) that can be produced using **Crane’s** recombinant methods. EX1003¶289. A POSITA would therefore be motivated to combine Proulx’s leghemoglobin with Conrad and Mottram for the same reasons set forth in Ground 1, with a reasonable expectation of success. *Supra* §VI. In particular, a POSITA would recognize that adding between 0.01-5.0% by weight of Proulx’s soybean-sourced leghemoglobin to Conrad’s meat replacement product (grain meat)

would contribute the same desirable aroma/flavor, meat-like coloration, and nutrition to Conrad's grain meat as Crane's recombinant leghemoglobin. *Supra* §VI (claims 1[c], 14[c], 27[c]); EX1003¶¶289-290.

**Proulx** teaches additional motivations to combine its leghemoglobin with plant-based foodstuffs such as Conrad's "grain meat." EX1003¶291. Proulx's underlying objective "is to introduce the concept of using plant hemoglobin as a heme iron source in" human diets, and it shows leghemoglobin has "great potential to be used as a fortificant for improving nutrition." EX1019, 1518, 1522.

Specifically, Proulx teaches that "[h]eme iron bioavailability has long been known to have higher bioavailability...than nonheme iron." EX1019, 1520. As taught in Proulx, soybean-sourced leghemoglobin "showed similar bioavailability" to bovine hemoglobin in a food matrix. *See, e.g.*, EX1019, Abstract, 1518, 1520, 1521 ("Our results showing the bioavailability of hemoglobin from soy root nodules similar to that of heme iron from animal sources when added with tortillas provide a unique alternative fortificant, hence to improve the iron status of the population."); PO agrees. In its "generally recognized as safe" (GRAS) submission to the FDA for soy leghemoglobin, PO noted that bioavailability of iron in soy leghemoglobin is equivalent to that of bovine myoglobin when in a food-like substrate. EX1052, 7 (citing EX1019); EX1003¶¶292-293.

A POSITA would also have been motivated to fortify Conrad’s “grain meat” with leghemoglobin because Proulx teaches the “high heat stability of...[heme] iron” compared to non-heme iron (EX1019, 1520, 1522), which a POSITA would recognize as advantageous in heated (cooked) foodstuffs. EX1003¶294. Proulx additionally teaches economic advantages of utilizing soybean leghemoglobin—e.g., that “[s]oy root nodules have no current use in agriculture production and as such may provide a novel value-added product for soy producers.” EX1019, 1522; EX1003¶295.

Thus, a POSITA would have been motivated to add purified soy leghemoglobin as taught by **Proulx** into **Conrad**’s meat placement products (e.g., Conrad’s “grain meat”) in order to fortify those compositions with heme iron as well as provide other benefits, particularly meaty flavor and color contributed by hemoglobin as taught in Conrad. Doing so would mimic the nutritional profile (and specifically, the heme iron content) of conventionally-sourced beef in Conrad’s replicas. EX1003¶296.

A POSITA would reasonably expect success in substituting **Proulx**’s leghemoglobin in **Conrad**’s wheat meat as Proulx teaches conventional extraction and purification methods for obtaining soybean leghemoglobin from plants for use in foodstuffs, which would require only ordinary skill to practice. EX1003¶¶298-299; *see also* §VI.A.5. 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, 1519 (describing “LHb Preparation” and bioavailability study design).

Proulx also teaches incorporating leghemoglobin in foodstuffs. EX1019 (“Tortilla Preparation. Unfortified masa harina . . . was fortified with 50 ppm iron with...LHbA [leghemoglobin], BHb...Masa harina (200 g) was mixed with fortificants...Masa harina was reconstituted with DI water (1:2 w/w), weighed to 25 g portions, flattened by tortilla press, and fried...”); EX1003¶¶300-301.

### 3. Claims 3, 16, 29

**Proulx**’s soybean-sourced leghemoglobin refers to the same protein as leghemoglobin produced via **Crane**’s recombinant techniques, but sourced from plants. See also claims 1, 14, 27. Accordingly, a POSITA would understand that the UV-VIS spectrum of Proulx’s leghemoglobin is “substantially similar” to that of myoglobin from an animal for the same reasons explained above for Crane’s recombinantly-produced leghemoglobin. EX1003¶¶302-304. See also §VI (same claims).

### 4. Claims 4, 17, 30

**Proulx** teaches using soybean-sourced leghemoglobin. See *supra* claims 1, 14, 27; EX1003¶¶305-306.

**5. Claims 6, 24**

**Proulx** teaches purifying its soybean leghemoglobin. EX1019, 1518 (“The objective of this study was to determine the iron bioavailability of...two purified soy leghemoglobins...”), 1519 (“Ion exchange chromatography...was used to further purify the LHb obtained from (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub> precipitation.”). See *supra* claims 1, 14, 27; EX1003¶¶307-308.

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

Conrad and Mottram render these limitations obvious. *Supra* §VI; EX1003¶309.

**VIII. GROUND 3: ROVAART, CONRAD, CRANE**

Claims 1, 3–9, 11, 13–14, 16–21, 23–24, 26–27, and 29–33 of the ’306 patent are obvious over Rovaart in view of Conrad and Crane. EX1003§XIV.

Like Conrad/Crane (*supra* §VI), **Rovaart** is analogous art as it teaches “the preparation of porous expanded food products having a meat-like taste,” which can be prepared from “*flour or meal of vegetable origin* rich in carbohydrates, or from *substances rich in protein of plant...origin.*” EX1125, 1:5-13; EX1003¶¶311-314. Rovaart provides that, because “it is desired to impart to [these products] the taste of meat,” the products “are subsequently given a flavouring treatment” (EX1125, 1:24-26), which simulates eating real meat. EX1003¶314.

To this end, **Rovaart** teaches that its “invention is concerned with a process for preparing an expanded porous food product having a meat-like flavour,”

comprising “(b) at least one pentose or hexose [sugars], (c) at least one sulphur-containing amino-acid or an amino-acid and a substance containing sulphur,” and “heating the mixture to a temperature of at least 150°C.” EX1125, 1:38-48. In addition to the desirable meaty flavors in Rovaart’s products, a POSITA would recognize Rovaart’s methods are advantageous because they are “particularly simple” and “the desired texture and taste are obtained in a single operation.” EX1125, 1:39-42; EX1003¶¶313-315.

## A. Claims

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

The preamble is not limiting. *Supra* §III.A. To the extent the preamble is limiting, Rovaart teaches this limitation.

**Rovaart** discloses a meat replica matrix and methods of imparting beef-like aroma thereto. EX1003¶¶318-319. Rovaart provides that, “[s]tarting from a substance rich in protein...*the final product has a fibrous structure analogous to the texture of meat and a meat-flavour.*” EX1125, 3:13-16. It discloses that “[t]he products..., to the extent that *it is desired to impart to them the taste of meat, are subsequently given a flavouring treatment*” comprising “suitable flavoring agents.” EX1125, 1:24-29.

In particular, as explained below for limitation [b], Rovaart teaches that incorporating sugars and sulfur-containing compounds impart a beef-like aroma to

its meat replica. As explained for limitation [c], a POSITA would be motivated to further enhance the meaty flavors and other meat-like properties of Rovaart's product using 0.01%-5% leghemoglobin taught in Conrad and Crane. As explained below for limitation [d], a POSITA would recognize that Rovaart's precursors generate at least two volatile compounds associated with beef-like aroma when heated. EX1003¶¶319-321.

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

Like Conrad (§VI), **Rovaart** teaches that its meat replica products—"food products having a meat-like taste," made from "*flour or meal of vegetable origin...or from substances rich in protein of plant...origin*"—comprise one or more plant proteins. EX1125, 1:5-13. Rovaart's "process comprises forming a mixture comprising (a) a finely divided food material," which refers to "material in the form of particles...such as...a material *rich in protein*, for example *soya bean flour*." EX1125, 1:42-44, 56-62; EX1001, 18:34-58 ("Non-limiting examples of plant sources include...plants from the legume family...e.g.,... soybeans...."). Certain Rovaart Examples utilize soybean flour: the Example 1 product comprises "10 kg of defatted soya bean flour" and the Example 2 and 4 products comprise "1000 g of a defatted soya bean flour." EX1125, 3:33-35, 5:23-24, 6:21-23; EX1003¶¶322-325.

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

**Rovaart** teaches including the claimed sugars and sulfur compounds in its products in order to achieve meat-like aromas. EX1003¶¶326-327. As a POSITA would recognize, these sugars and sulfur compounds are Maillard reaction precursors long known to produce volatile compounds associated with meaty aromas when heated. EX1005§V.B; see limitation [d] *infra*.

Rovaart provides that its “process for preparing an expanded porous food product having a meat-like flavour...comprises forming a mixture comprising...(b) at least one pentose or hexose, (c) at least one sulphur-containing amino-acid or an amino-acid and a substance containing sulphur.” EX1125, 1:38-46. It further discloses that “[t]he pentose or hexose...may be **D-ribose**, **D-xylose**, L-arabinose or **glucose**,” and “[c]ysteine is the preferred **sulphur-containing** amino-acid.” EX1125, 1:66-2:1; EX1003¶¶328-329.

Rovaart’s Examples disclose specific combinations of these sugars and sulfur compounds: the Example 1 methods comprises “83.3 g D-ribose, 66.7 g L-cysteine,” Example 2 comprises “D-Xylose” and “L-Cysteine,” and Example 4 comprises glucose and cysteine. EX1125, 3:32-37, 5:10-16, 5:38-40, 6:17-20; EX1003¶¶330-331.

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

**Conrad** motivates a POSITA to add 0.01%-5.0% of heme-containing protein to a meat replica, and a POSITA would be motivated to substitute Conrad's blood-sourced hemoglobin protein in **Rovaart's** products with **Crane's** purified leghemoglobin, which contributes the same desirable coloration, flavor, and nutritive benefits as hemoglobin, with a reasonable expectation of success. EX1003¶333.

**Rovaart** generally motivates a POSITA to provide meaty flavor in its products. E.g., EX1125, 1:5-7 (“The present invention is concerned with *the preparation of* porous expanded *food products having a meat-like taste.*”). To this end, Rovaart teaches including “*suitable flavouring agents*” in its products, “which may be natural.” EX1125, 1:24-29. Rovaart teaches adding sugars/sulfur-compounds for this purpose (*see* limitations [b], [d]); EX1003¶334.

Rovaart also teaches methods of *enhancing*—not merely producing—meaty flavor, which a POSITA would recognize as advantageous for preparing a meat-like foodstuff. EX1003¶335. These methods include increasing the products' cooking temperature, as Rovaart teaches that “heating [Rovaart's composition] at a temperature below 150°C does not produce the desired flavour.” EX1125, 2:46-51. Rovaart also teaches that changing its processes (e.g., by sugar substitution) can produce “less pronounced” meaty flavors. EX1125, 6:16-28. 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. A POSITA would recognize that one way to do so would be to include other “natural” “suitable flavouring agents” in the products. EX1003¶¶336-337.

**(a) Motivation to Combine with Conrad**

To further enhance **Rovaart**’s products’ meaty flavor, **Conrad** teaches a POSITA that adding “up to” about 5% heme-protein by weight would contribute meaty flavor in addition to other benefits. EX1003¶338.

Conrad discloses “grain meat”/“wheat meat” meat replica matrices that advantageously contain heme-protein (hemoglobin). *Supra* §VI. 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, 4:3-17; EX1003¶339.

As discussed in greater detail for Ground 1 (§VI.A.4 *supra*), Conrad teaches levels of heme-protein in foodstuffs that achieve these desirable meat-like properties. EX1003¶¶340-355. The range taught in Conrad almost completely

overlaps with the claimed range, thereby rendering it obvious. *Almirall*, 28 F.4th at 272.

Following the teachings of **Conrad**, a POSITA would be motivated to add 0.01%-5% heme-protein to **Rovaart**'s "meat-like" food product in order to achieve desirable meat-like properties, with a reasonable expectation of success. Additionally, a POSITA would understand that incorporating levels of heme-protein near the lower boundary of the claimed range could desirably replicate proportions of heme-protein naturally present in various kinds of meat. EX1003¶¶356-357; EX1027, 65.

#### (b) Motivation to Combine with Crane

As explained further above for Ground 1 (§VI), a POSITA would be motivated to substitute Conrad's blood-sourced hemoglobin with Crane's recombinantly-produced heme-proteins, and reasonably expect success doing so. **First**, a POSITA would be generally motivated to substitute **Conrad**'s conventionally-obtained hemoglobin with heme-proteins from alternative sources as obtaining blood from slaughtered animals incurs the same consequences as cultivating animals for meat. EX1003§VIII.A. **Conrad** likewise teaches utilizing meat replicas in place of "animal meat." EX1013, 1:25-40. **Crane** also teaches using its recombinant heme-proteins in place of conventionally-sourced proteins.

EX1014, [0062] (“Recombinant hemoglobin preparations are used as...an alternative to blood transfusion.”); EX1003¶¶358-361.

**Second, Conrad** teaches avoiding conventionally-sourced meat due to its relative expense and motivates lowering costs of manufacture. EX1003¶¶362-363; EX1013, 1:25-40 (teaching that “**replac[ing]** some of the **animal meat tending to be somewhat expensive**....would be **desirable...from a cost benefit point of view**....”). **Crane** also provides a similar motivation as it teaches heme-proteins can be produced via a “**simple and inexpensive method**” which “is effective at producing fully incorporated heme proteins.” EX1014, [0085]; [0014] (“The present invention is a straightforward and **inexpensive method**....”); [0043] (“**[F]ungal [expression] systems are more efficient and economical**....”).

**Third, Crane’s** heme-proteins can be purified, which is desirable for a commercial application such as **Rovaart’s** food product—*e.g.*, to achieve standardized ingredients and promote product stability. EX1014, [0024], [0060]-[0062]. Thus, a POSITA would be motivated to utilize Crane’s heme-proteins instead of slaughtered-animal blood. EX1003¶364.

**Crane** teaches methods of obtaining various heme-proteins. EX1014, [0021]. As discussed in greater detail for Ground 1 (§VI.A.4 *supra*), a POSITA would be motivated to utilize Crane’s hemoglobin, myoglobin or leghemoglobin in Rovaart’s products, as a POSITA would expect doing so to contribute (1) **desirable meat-like**

**coloration, (2) desirable aroma/flavor, and (3) desirable meat-like nutrition.**

EX1003¶¶365-366.

*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 in **Rovaart**’s products. A POSITA would expect leghemoglobin to have a similar flavor contribution. EX1003¶¶369-370.

*Color:* A POSITA would understand that heme-proteins (e.g., myoglobin and hemoglobin) are “predominant” red pigments in animal muscle and denature when heated, causing meat’s browning. EX1027, 64; EX1094, 82. **Crane**’s recombinant hemoglobin/myoglobin—the same as heme-proteins as in animal muscle—would be expected to contribute to color in the same manner. EX1003¶367.

Likewise, leghemoglobin provides meat-like color to plants. EX1030, 79 (leghemoglobin is “red pigment isolated from soybean root nodules”), EX1135; EX1133. A POSITA would therefore expect **Crane**’s recombinant leghemoglobin to achieve similar meat-like coloration in **Rovaart**’s products as myoglobin/hemoglobin achieves in meat. EX1003¶368.

*Nutrition:* Meat is an important dietary source of iron and “haem[sp:heme] iron [is] more readily absorbed and utilised by the body” than other forms. EX1029, 329. E.g., the heme-protein myoglobin provides 95% of the iron in beef. EX1027, 64-65. **Crane**’s recombinant myoglobin, hemoglobin, and leghemoglobin is “fully

incorporated” with heme iron and would therefore be desirable to enhance the nutrition profile of **Rovaart**’s products. EX1014, [0080], [0084]-[0085]; EX1003¶371.

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

Rovaart teaches cooking its meat replica products. EX1003¶372-373. Rovaart’s process comprises “heating the mixture to a temperature of at least 150°C,” “preferably...at a temperature of between 160° and 180°C,” under pressures “sufficient to produce a meat flavour in the interior of the final product.” EX1125, 1:38-48, 2:63-68.

As a POSITA would recognize, heating the Rovaart products will naturally generate at least two compounds associated with beef-like aroma. EX1003¶374. As explained above for Ground 1, the art long taught that when sugars and sulfur compounds (*e.g.*, as used in **Rovaart**’s products, *see* limitation [b] *supra*) are heated together, they will undergo the Maillard reaction to produce many volatiles associated with meaty aromas, including meat’s character-impact compounds. EX1005§§V.B & VIII (reviewing EX1017, EX1032–1034, EX1038, EX1041, EX1045, EX1099, EX1129).

A POSITA would expect success achieving this limitation because the claimed result is taught or suggested in **Rovaart**. EX1003¶375. For example, heating Example 2’s product (containing xylose/cysteine) “at 158°C” “provides *a*

*product having the flavour of boiled beef* and a meat-like texture.” EX1125, 5:10-

36. A similar “**boiled beef**” flavor is produced when the same process is performed, substituting glucose for xylose. EX1125, 6:16-28 (Example 4).

Moreover, only ordinary skill would be required to prepare and assemble the individual components—e.g., **Crane**’s purified recombinant leghemoglobin—into **Rovaart**’s meat replica matrix and heat to generate at least two volatile compounds associated with beef-like aroma. Rovaart teaches conventional methods of mixing, heating, and extruding ingredients. E.g., Example 1 (teaching mixing “soya bean flour...and 53.5% protein...with 3250 g of an aqueous solution...The resulting dough...is introduced into the feed hopper of an extruder...The dough is...advanced...at a temperature of 160°C....”); EX1003¶377.

## 6. Claims 3, 16, 29

A POSITA would be motivated to utilize **Crane**’s recombinant leghemoglobin/myoglobin in **Rovaart**’s “meat-like” food products as more fully explained above. *Supra* claims 1, 14, 27.

As discussed in greater detail with respect to §VI.A.6, the art taught a high degree of structural homology between myoglobin and leghemoglobin. EX1135, 133, 139; EX1133, 1032. PO acknowledges leghemoglobin naturally “has a virtually identical absorbance spectrum and visual appearance to myoglobin from animal muscle.” EX1012, [00377] & Fig. 5. Additionally, Crane’s recombinant

myoglobin is the *same* protein as animal myoglobin “from an animal,” differently sourced. EX1003¶¶378-382.

#### 7. Claims 4, 17, 30

As explained more fully above (claims 1, 14, 27), a POSITA would be motivated to substitute **Conrad**’s conventionally-sourced hemoglobin with **Crane**’s leghemoglobin in **Rovaart**’s products, with a reasonable expectation of success. Like hemoglobin from slaughtered-animal blood, leghemoglobin has a red, meat-like pigment that would be desirable in meat replica foodstuffs. EX1030, 79; EX1003¶¶383-384.

A POSITA would also recognize that a variety of “non-animal” heme-proteins, such as plant hemoglobins, could be manufactured using Crane’s techniques and could also be used for this purpose. EX1030 (reviewing “six decades” of research on plant hemoglobins); EX1014, [0021] (“[C]lasses of heme-binding proteins that are encompassed by the methods of the present invention include...hemoglobin,....The recombinant heme-binding protein produced using the methods of the present invention can be prokaryotic or eukaryotic.”); EX1003¶385.

#### 8. Claims 5, 18, 31

As explained above (claims 1, 14, 27), **Conrad** teaches advantages of adding between 0.01%-5.0% of blood-sourced heme-protein to Rovaart’s products, EX1013, 1:56-61, which a POSITA would be motivated to substitute with **Crane**’s

leghemoglobin. EX1003¶¶386-387. *See also supra* §VI (claims 5, 18, 31). This heme-protein range encompasses, and thus renders obvious, the claimed 0.4%-1% limitation. *Almirall*, 28 F.4th at 272.

Additionally, a POSITA seeking to replicate real beef using a “meat-like” Rovaart product would be motivated to incorporate between approximately 0.4%-1% by weight of “non-animal” heme-protein, the levels naturally present in certain kinds of beef. EX1003¶¶388; EX1027, 65.

#### 9. Claims 6, 24

As explained above (claims 1, 14), **Crane** teaches methods of producing purified heme-protein preparations by separating heme-proteins from other components of Crane’s expression systems, e.g., via cleavable “tags” attached to the protein when initially expressed. EX1014, [0060]-[0062]; *see also id.* [0074], [0075] (teaching heme-proteins “purified to >95% purity”). EX1003¶¶389-392. *See also supra* §VI (claims 6, 24).

#### 10. Claims 7, 19

As explained above (claims 1, 14), **Rovaart** teaches that the “soya bean” (soybean) flour used in Rovaart’s Examples contains protein and is “defatted.” EX1125, 1:56-63 (teaching “material rich in protein, for example soya bean flour”); 5:23-25, 6:20-23, 6:42-44. A POSITA would understand that the protein-containing soybean flour had been isolated from other components of the soybean. Soybean

flour is typically “defatted,” a process in which the oily fraction is separated from other bean components. One advantage of defatting flour is to preserve taste and shelf life, as oil is known to oxidize and become rancid. EX1003¶¶393-397; EX1140, [0071]. Accordingly, a POSITA would understand that the soybean flour used in Rovaart’s Examples had been isolated from other bean components such as the bean’s fats. EX1003¶¶398; EX1001, 17:33-51, 20:32-37.

POSITAs would be motivated to isolate proteins for use in Conrad’s meat replicas (*e.g.*, to avoid off-flavors and increase shelf-life) and would reasonably expect success doing so given known isolation/purification techniques. EX1003¶399 & Ground 5 *infra*.

#### 11. Claims 8, 20

As explained above (claims 1, 14), a POSITA would understand that **Rovaart**’s soybean flour contains proteins separated (“purified”) from other plant components (*e.g.*, bean oil). A POSITA would be generally motivated to further purify the isolated proteins in Rovaart’s soybean flour, *e.g.*, to eliminate components of the source material that could contribute to off-flavors. *See also supra* claims 7, 19. EX1001, 17:33-51, 20:32-37. As the art taught such techniques, a POSITA would reasonably expect success. EX1003¶¶400-403.

## 12. Claims 9, 21, 32

As explained above (claims 1, 14, 27), **Rovaart** teaches the use of legume proteins in its products, as certain Rovaart Example products utilize soybean (plant) flour. EX1125, 5:10-25, 6:16-23, 6:29-44. Rovaart teaches that soybean flour contains proteins. EX1125, 1:56-62 (disclosing “*material rich in protein, for example soya bean flour*”). EX1003¶¶404-406; EX1001, 18:42-46.

## 13. Claims 11, 23

**Rovaart**’s manufacturing methods involve adding “water, the mixture...containing from 18 to 45% by weight of water.” EX1125, 1:42-47. Accordingly, the “dry” (non-water) components of the Rovaart method can comprise 55% of the product, and up to 52% soybean flour. Of the dry components, Rovaart teaches using defatted soybean flour in its products, which a POSITA would understand could comprise approximately 50% protein. *Supra* claims 1, 14; EX1125, 1:56-65; EX1126, 1 (“51.1 g”/51.1% protein in 100g “defatted soybean flour”). Thus, the Rovaart products could comprise plant protein content of about 27%, within the claimed 1-30% range. EX1003¶¶407-411.

## 14. Claims 13, 26, 33

**Rovaart** teaches meat-flavored food products (the “meat replica matrix”) which a POSITA would understand could substitute for conventionally-sourced meat in the claimed consumables/compositions. EX1003¶¶412-414; EX1125, 3:13-16 (final product has “fibrous structure analogous to the texture of meat”).

For reasons explained more fully above (§VI, claims 13, 26, 33), a POSITA would understand that cooking a consumable/composition comprising Rovaart's sugar/sulfur compound-containing meat-flavored food product would produce “substantially higher” amounts of aroma-associated volatiles than cooking the consumable alone—i.e., “the consumable product lacking the meat replica matrix.” EX1003¶¶415-417. *See also supra* claims 1, 14, 27.

#### **IX. GROUND 4: ROVAART, CONRAD, PROULX**

The combination of Rovaart, Conrad, and Crane is obvious as explained above for Ground 3. EX1003§XV; §VIII, *supra*. For the same reasons explained above in Ground 2 (§VII, *supra*), a POSITA would be motivated to substitute **Proulx**'s soybean-sourced leghemoglobin for **Crane**'s recombinant leghemoglobin in each of the challenged claims of Ground 3 (1, 3–9, 11, 13–14, 16–21, 23–24, 26–27, and 29–33) with a reasonable expectation of success, and they are therefore obvious. EX1003¶¶418-419.

#### **X. GROUND 5: ROVAART, CONRAD, CRANE/PROULX, CHO**

Claims 7–8 and 19–20 of the '306 patent are obvious over Rovaart in view of Conrad, either Crane or Proulx, and Cho. EX1003§XVI. The combination of Rovaart and Conrad with either Crane or Proulx is obvious as explained above in Grounds 3–4. §§VIII-IX, *supra*.

A POSITA would be motivated to combine Cho with Rovaart, Conrad, and Crane/Proulx because Rovaart’s products comprise soybean flour and, as provided *infra*, Cho teaches that isolating and purifying soy proteins for use in foodstuffs improves flavor by eliminating components such as fatty acids that oxidize and produce “objectionable off flavors” (e.g., rancidity). EX1003¶¶420-426; EX1140, [0001], [0004]–[0014]; *see id.* [0013] (“The soy protein isolate is suitable for use in a number of foods...”), [0060] (noting “highly desirable” “bland taste” of soy protein isolate).

Utilizing **Cho**’s methods, POSITA would therefore be motivated to utilize Cho’s teachings in preparing **Rovaart**’s products with a reasonable expectation of success—e.g., by reducing “beany” qualities of soybean flour that could negatively impact the products’ desired meaty flavor. EX1003¶427.

## A. Claims

### 1. Claims 7, 19

**Cho** teaches conventional methods of isolating soy proteins from the other components of the soybean, using solvent-based extraction (EX1003¶¶428-429). E.g., Cho teaches “[t]he *conventional process for manufacturing soy protein isolate begins with the production of a full fat soy flake from the bean*, which is substantially *defatted....Soy protein is then extracted...and separated from the insoluble vegetable matter....*The extracted protein is precipitated, washed, re-

suspended in water and spray dried....” EX1140, [0006]; [0037] (describing “first step” in process).

## 2. Claims 8, 20

**Cho** teaches purifying soy proteins (including isolates), *e.g.*, to further reduce undesirable bean-associated aromas by eliminating unwanted components such as fats. EX1003¶¶430-431. Cho motivates further purification because, even using conventional isolation techniques, “[a]ppreciable quantities of the flavor-active volatiles...may continue through the subsequent protein isolation steps to result in a soy protein isolate with the familiar grassy, beany flavors.” EX1140, [0007].

Accordingly, Cho teaches additional purification steps including “re-solubiliz[ing],” “heating,” precipitating, and neutralizing soy protein isolate “slurr[ies].” EX1140, [0011]–[0014]. Cho teaches that these processes, which have desirably-reduced levels of unwanted components such as fats and isoflavones (EX1140, [0015]-[0030]) “produc[e] soy protein isolates having excellent functionality and presenting a bland [non-objectionable] taste.” EX1140, [0011], [0034]; EX1003¶432.

## XI. GROUND 6: CONRAD, MOTTRAM, CRANE/PROULX, CHO

The combination of **Conrad**, **Mottram**, and **Crane/Proulx** is obvious as explained above for Grounds 1-2. EX1003§XVII; §VI-VII, *supra*.

For the same reasons explained above in Ground 5 for claims 7–8 and 19–20 (§X, *supra*), a POSITA would also be motivated to utilize **Cho**’s teachings to prepare the grain meat of Conrad, with a reasonable expectation of success. The isolation and purification principles taught in Cho are relevant for the preparation of Conrad’s grain meat, *e.g.*, because Conrad’s product contains “wheat germ oil” which could become rancid. A POSITA would be motivated to use conventional techniques to purify **Conrad**’s wheat (plant) gluten proteins in order to eliminate objectionable flavors (which could detract from the “meat-like” properties of Conrad’s replica), and would reasonably expect success. EX1003¶¶433-436.

## **XII. GROUND 7: CONRAD, MOTTRAM, CRANE/PROULX, BOYE**

Claims 9–10, 21–22 and 32 of the ’306 patent are obvious over Conrad in view of Mottram, either Crane or Proulx, and Boye. EX1003§XVIII. The combination of Conrad and Mottram with either Crane or Proulx is obvious as explained above in Grounds 1–2. §§VI-VII, *supra*.

A POSITA would be motivated to combine Boye with Conrad, Mottram, and Crane/Proulx because, as provided *infra*, **Boye** teaches advantages of utilizing pea proteins, specifically pea albumins, in meat-substitute foodstuffs, “especially when blended with cereal[grain] proteins” as taught in Conrad. EX1016, Abstract. A POSITA would therefore be motivated to utilize pea proteins (pea albumins) in the

grain-based meat replica of **Conrad**, with a reasonable expectation of success.

EX1003¶¶437-439.

## A. Claims

### 1. Claims 9, 21, 32

**Boye** teaches that “[p]ulses *constitute an important source of dietary protein* for large segments of the world’s population particularly in those countries in which the consumption of animal protein is limited by nonavailability or is self-imposed because of religious or cultural habits.” EX1016, 415. Using “pulses *such as pea*,” which “are an *important source of food proteins*,” “to meet some of the protein malnutrition problem worldwide is...*of tremendous interest*.” EX1016, 415, Abstract; EX1003¶¶440-442. Thus, a POSITA would understand pea proteins are a desirable alternative source for the protein used in Conrad’s “grain meat.” EX1003¶441.

Boye discloses “current and emerging food application opportunities for pulses and their protein fractions,” including as meat substitutes. EX1016, 424. In particular, Boye teaches that “[p]ulse *flours and fractions have been used successfully as ingredients in the formulation of meat products* (e.g., burgers, sausages, nuggets, etc.),” and, e.g., that using *cowpeas* “*increased the protein content of the meatballs or comminuted meat products*.” EX1016, 425; EX1003¶¶444-445.

## 2. Claims 10, 22

**Boye** teaches that pea albumins, which “represent[] 15–25%...of the total [pea] protein” (EX1016, 417), provide certain nutritional benefits. E.g., Boye discloses that “*pea albumin was a superior source of another essential amino acid, tryptophan,*” and, “[c]ompared to the globulins, pea albumins contain more of the essential amino acids tryptophan, lysine, threonine, cysteine and methionine.” EX1016, 416, 417–418; EX1003¶¶446-447.

### XIII. GROUND 8: ROVAART, CONRAD, CRANE/PROULX, BOYE

Claims 9–10, 21–22 and 32 of the ’306 patent are obvious over Rovaart in view of Conrad, either Crane or Proulx, and Boye. EX1003§XIX. The combination of Rovaart and Conrad with either Crane or Proulx is obvious as explained above in Grounds 3–4. §§VIII-IX, *supra*.

A POSITA would be motivated to combine Boye with Rovaart, Conrad, and Crane/Proulx with a reasonable expectation of success because, as provided *supra* (Ground 5), **Boye** teaches nutritional advantages of utilizing pea proteins, specifically pea albumins, in “extruded products” such as **Rovaart**’s plant-based products. EX1003¶¶448-450; EX1016, Abstract.

### XIV. SECONDARY CONSIDERATIONS

No secondary considerations of non-obviousness support the patentability of the ’306 patent claims.

**A. No “Surprising” or “Unexpected” Results Support Patentability**

PO cited certain experiments and accompanying affidavits in support of purportedly “surprising” or “unexpected” results from the combination of a heme protein (leghemoglobin) with select Maillard precursor molecules (ribose and cysteine) compared to the same reaction conditions but without the heme protein. EX1148, 2717. PO’s characterization of the significance of such experiments is meritless. EX1005§VIII.

**1. PO’s Experiments Fail to Show Beef-Like Aroma**

Neither PO’s arguments nor experimental data show that the resulting aroma of the heme protein-containing reaction(s) of Maillard reaction precursors more accurately mimics the aroma of meat than the aroma produced from the non-heme protein containing reactions. EX1005§VIII.D. PO did not provide *any* organoleptic data for its experimental aromas to show how the volatiles produced in these experiments would be sensorily perceived. EX1005¶¶VIII.D.1. *E.g.*, certain precursors under certain conditions can result in flavor-significant levels of volatiles that overpower other aromas. EX1005¶¶158-159; EX1100 (methionine can generate “boiled potato” aroma).

Nor did PO show that *heme-protein* creates desired aroma *any more than any other protein would*. PO’s experiments lack appropriate controls that would permit this conclusion. EX1005¶¶161.

Nor still did PO account for the chemical complexity of cooking heme-protein and Maillard precursors in the claimed “meat replica matrix.” EX1005¶¶162-166. The combination of Maillard reactants and heme-protein with plant proteins and other components of a meat replica—as claimed—could result in a non-“beef-like” volatile profile. EX1005¶¶164.

PO and its experts implied that increasing the levels of certain volatile compounds would translate into an improved meaty aroma. EX1005§VIII.F & ¶167. Not so. Merely increasing the amounts of volatiles—particularly character-impact compounds for meat flavor such as MFT—would *not* necessarily increase the desired aroma and could in fact affect it *adversely*. EX1005¶168. If sulfur volatiles are overabundant in meat aromas, the aromas’ characteristics become unpleasant, contributing to off-flavors. EX1005¶¶168-169; EX1031, 16; EX1129, 967 (“Among the most important contributors to the characteristic aroma of cooked meat are [MFT]....These compounds have extremely low odor threshold values, and consequently ***only trace amounts are needed for meatlike aromas; indeed, at higher concentrations many of the compounds become unpleasantly sulfurous in character.***”); EX1017, 421 (“At high concentrations the furanthiol derivatives have strong, sulfurous odours, and ***it is only at low concentrations that meaty aromas become apparent.***”); 418 (“[M]eaty...aromas are detected at low concentrations...but at higher concentrations, the aromas are perceived as sulfurous

and objectionable.”). Thus, the volatiles reported by PO could translate to an unbalanced, unpleasant, sulfurous, non-meaty aroma. Without a sensory evaluation, it is impossible to know. EX1005¶169.

Moreover, PO’s identified volatiles are also found in the aromas of diverse non-meat foodstuffs such as fruits, coffee, wine, and grains. EX1005¶¶170-172. Without sensory evaluation, PO’s experimental aromas are unknown.

Contrary to PO’s assertions (EX1148, 2720), certain Examples in the ’306 patent specification also fail to support patentability for similar reasons. EX1005¶¶139-151 (Exs. 16, 17, 33). *E.g.*, they lack adequate controls to connect aroma to *heme-protein* (and not Maillard precursors) and fail to account for the chemical complexity of the claimed meat replica matrix, which could affect aroma. EX1005¶¶142-143.

## 2. PO’s Volatiles Are Not Novel

Compounds that PO urged were produced *exclusively* under heme-protein-containing conditions—including MFT and MFT-MFT—are long known to be produced from cysteine/ribose precursors *even in the absence of heme-proteins*. EX1005¶¶178-179; EX1129, 985 (describing cysteine, ribose, and lecithin reactions, “[i]n...aqueous systems, in the absence of lipid, the major volatile components were thiols such as 2-methyl-3-furanthiol [MFT]...”); EX1045, Abstract (“[A] thermally treated solution...of cysteine/ribose led to the identification

of...[MFT]...and [MFT-MFT]...”). PO should be aware of this relationship at least based on its reliance on Calkin, which teaches that “[c]ysteine and ribose, through the Maillard reaction, as well as thiamin have been shown to create...[MFT]....” EX1028, 65; EX1148, 2715.

Similarly, 2-acetylthiazole and thiophene are produced via the Maillard reaction in the absence of heme-protein. EX1005¶¶179-180; EX1118, Abstract (“[A] reaction of d-glucose and l-cysteine was constructed to investigate the formation pathway of 2-acetylthiazole.”); EX1017, 417 (“[T]he Maillard reaction....lead[s] to many important classes of flavour compounds including...thiophenes.”).

**B. A POSITA Would Not Be Discouraged from Adding Heme-Protein to a Meat Replica**

Lipid oxidation contributes positively to meaty flavor. EX1005§VIII.B. Mottram teaches that, even though meat is “more susceptible to oxidation,” its fatty acids “provide *lipid oxidation products during the initial cooking of meat* which *contribute to desirable aromas*.” EX1017, 420. Yamaguchi similarly teaches that, when “subjected to oxidization...the body taste of the foods will be improved and the original tastes of the foods will be increased.” EX1022, [0026]. Conventionally-sourced meat—a popular food—contains heme-proteins, notably myoglobin and hemoglobin, which naturally contribute to meaty aroma when cooked. EX1005¶¶134-135.

A POSITA would recognize that, *over time, days after* heme-protein denaturation upon cooking, heme-catalyzed oxidation could produce undesirable “warmed-over” flavor (EX1017, 420; EX1048, 287), but this would not discourage a POSITA from incorporating a protein naturally present in meat into a meat replica. EX1005¶¶136-137. Thus, it is inaccurate and an oversimplification for PO to argue that lipid oxidation always exerts a negative impact on aroma.

**C. No Skepticism, Failure of Others, or Long Felt, Unmet Need**

There is no skepticism about the ’306 patent claims given the long-known association of the claimed Maillard precursors and generation of meaty aromas. EX1005¶¶220-221.

Nor do PO’s claims satisfy long-felt need unachieved by others. In fact, PO’s product’s aromas are *less beef-like* than its competitors. EX1005¶¶222-230. An independent study in 2021 evaluated eight different plant-based burgers, including PO’s product, to determine which most closely resembled typical burger aroma. EX1005¶¶222-224, EX1098. PO’s burger was not one of the top performers as it “gave off notes of yeast and grain,” which are not typical aromas associated with cooked beef. EX1005¶¶225-226, EX1114, EX1115. Indeed, the superior burgers did not contain heme-proteins. EX1005¶¶227. Rather, the winner’s (Beyond Burger) improved aroma was attributed to the presence of canola and coconut oils,

which are more similar to animal fatty acids than the sunflower oil in PO's burger product. EX1005¶¶228-230, EX1146.

**D. No Nexus to Commercial Success**

PO's plant-based burgers contain leghemoglobin. EX1121, 2-3. But meaty, beef-like aroma is contributed by a variety of factors such as Maillard reaction products and lipid degradation, not heme-proteins. EX1005¶¶231. Rather, PO's commercial success is attributable to its aggressive marketing campaign. EX1005¶¶234-235; EX1120, EX1147.

**XV. INSTITUTING *INTER PARTES* REVIEW WOULD BE EQUITABLE**

The Board should not exercise its discretion to deny institution under 35 U.S.C. §325(d). The art asserted here is materially different from that examined in prosecution. The Grounds rely on prior art which was not cited or discussed during prosecution—e.g., Conrad, Rovaart, and Crane. Mottram was cited but not discussed. Proulx was discussed but PO did not persuade the Examiner that combinations with Proulx were non-obvious. EX1148, 3267. The Examiner also did not consider any combination of references similar to or cumulative to those asserted in this Petition—e.g., teaching flavor benefits of heme-protein.

Moreover, PO was unable to persuade the Examiner regarding the non-obviousness of the claims until PO suggested “surprising” and “novel” aroma/volatiles arising from inclusion of heme-protein, which is incorrect as

explained above. §XIV.A. However, the Examiner also did not have the benefit of McGorin's expert testimony regarding the unpersuasiveness of PO's proffered support, as here (EX1003, EX1005, EX1007). The Examiner's incorrect conclusion indicates they were unaware of the inadequate design of PO's experiments (EX1005§VIII), and moreover, that such results are merely in line with what a POSITA would predict from the prior art rather than surprising.

The Examiner also did not have the benefit of Petitioner's other expert testimony. For example, Drs. Tarte and Batt opine that a POSITA would have been motivated to manufacture recombinant heme-containing proteins and add them to meat flavoring compositions. *See, e.g.*, §§VI, VIII. The Examiner may not have appreciated that this was even possible.

The Examiner also erred in failing to consider references teaching use of heme-containing proteins to flavor meat replicas (like Conrad). §§VI-VII. The additional evidence and facts presented in this Petition warrant review.

**XVI. REQUIREMENTS FOR *INTER PARTES* REVIEW (37 C.F.R. §§ 42.101, 42.104, AND 42.108)**

Petitioner certifies that the '306 patent is available for *Inter Partes* Review and that Petitioner is not barred or estopped from requesting this proceeding.

**XVII. CONCLUSION**

Petitioner has demonstrated a reasonable likelihood that all Challenged Claims are obvious. Accordingly, review is requested.

## **XVIII. MANDATORY NOTICES**

As set forth below and pursuant to 37 C.F.R. §42.8(a)(1), the following mandatory notices are provided as part of this Petition.

### **A. Real Party in Interest**

Motif FoodWorks, Inc. is the real party-in-interest.

### **B. Related Matters**

Impossible Foods Inc. v. Motif Foodworks, Inc., Case Number: 22-cv-00311-WCB,  
District of Delaware

IPR2023-00206 (US 9,943,096)

IPR2023-00207 (US 11,224,241)

IPR2023-00208 (US 11,013,250)

### **C. Lead and Back-Up Counsel (37 C.F.R. § 42.8(b)(3))**

Petitioner hereby designates lead and backup counsel as follows. Pursuant to 37 C.F.R. § 42.10(b), a Power of Attorney accompanies this Petition.

| <b>Lead Counsel</b>                                                                                                                                                                                                                                         | <b>Backup Counsel</b>                                                                                                                                                                                                                                                                                   |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Joseph M. Paunovich (Reg. No. 59,044)<br>qeimpossibleipr@quinnemanuel.com<br><br>Postal and Hand Delivery Address:<br>QUINN EMANUEL URQUHART<br>& SULLIVAN, LLP<br>865 S. Figueroa St., 10th Floor<br>Los Angeles, California. 90017<br>Tel: (213) 443-3000 | James Glass (Reg. No. 46,729)<br>Sandra Haberny (Reg. No. 64,150)<br>Razmig Messerian (Reg. No. 56,983)<br>Quincy Lu (Reg. No. 76,954)<br>qeimpossibleipr@quinnemanuel.com<br><br>Sarah Cork ( <i>pro hac vice</i> to be<br>requested upon grant authorization)<br><br>qeimpossibleipr@quinnemanuel.com |

|                     |                                                                                                                                                                                                   |
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|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

**D. Service Information (37 C.F.R. § 42.8(b)(3)-(4))**

Please send all correspondence to the lead and backup counsel at the addresses shown above. Petitioner consents to service by e-mail at the addresses of lead and back-up counsel shown above.

**E. Payment of Fees**

The undersigned authorizes the Office to charge the fee required for this Petition for *Inter Partes* Review to Deposit Account No. 50-5708. Any additional fees that might be due are also authorized.

DATED: December 7, 2022

Respectfully submitted,

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*Lead Attorney for Petitioner Motif  
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**CERTIFICATE OF COMPLIANCE**

Pursuant to 37 C.F.R. § 42.24(a) and (d), the undersigned hereby certify that the PETITION FOR *INTER PARTES* REVIEW complies with the type-volume limitation of 37 C.F.R. § 42.24(a)(i) and (b)(i) permitting a petition of up to 14,000 words because, exclusive of the exempted portions, it contains 13,812 words as counted by the word processing program used to prepare the paper.

Date: December 7, 2022

Respectfully submitted,

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**CERTIFICATE OF SERVICE**

In accordance with 37 C.F.R. §§ 42.6(e) and 42.105, the undersigned certifies that the foregoing PETITION FOR *INTER PARTES* REVIEW OF U.S. PATENT NO. 10,039,306 and supporting materials were served on Patent Owner by USPS Overnight Express Mail at the following address of record for the subject patent:

Dr. M. Angela Parsons  
Fish & Richardson P.C.  
P.O. Box 1022  
Minneapolis, MN 55440-1022  
Attorney Docket No. 38767-0019002

Courtesy copies of the same documents were served on Patent Owner by USPS Overnight Express Mail at the following address of record for litigation counsel:

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Date: December 7, 2022

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