

METHOD AND SYSTEM FOR OPTIMIZING A BLENDING FORMULATION OF
AN EDIBLE OIL SAMPLE, AND AN EDIBLE OIL SAMPLE PREDICTED
THEREFROM

5

Cross-Reference To Related Application

[0001] This application claims the benefit of priority of Singapore patent application No. 10202000216P, filed 9 January 2020, the content of it being hereby incorporated by reference in its entirety for all purposes.

10

Technical Field

[0002] Various embodiments relate to a method for optimizing a blending formulation of an edible oil sample, and an apparatus or system therefor, as well as an edible oil sample having a blending formulation predicted using the method in accordance with various embodiments.

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Background

[0003] Formulations of oil blends have been widely explored for various cooking purposes.

[0004] Most commonly used frying oils include pure oil, such as palm oil, sunflower oil, soybean oil, high oleic sunflower oil, amongst others. Edible vegetable oils in their pure form have limited industry applications, due to their specific chemical and physical properties. As a result, blended oils, which are formed by mixing different types of oils, are commonly used especially in the area of frying foods. Frying oil is often required to be stable for a long time at high temperature, produce as little toxic chemicals as possible at high temperature, provide good flavor, and have a reasonably low or affordable price. However, provision of oil blends that satisfy all the requirements mentioned above has always been difficult and challenging.

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[0005] Conventional ways of creating or adjusting formulations of oil involve lab experiments or calculations using spreadsheets, for example, in the Microsoft Excel. However, such approaches may lead to high inaccuracy and may have low efficiency. Some computational methods for optimization have also been explored and there have
5 only been a few prior publications on applying deep learning to design and optimize formulations of oil blends. The types of algorithm explored may be limited and may differ with respect to a number of factors, for example, the input information, the constraints and/or the outputs required outside of the optimization process.

[0006] Previous studies have reported characteristics of blended oils that are based on the
10 oil availability, cost and simple calculation of fatty acid profile. However, none of the studies have considered the space of blending a large number of pure oils and/or oil blends and constraints pertinent to the industry of fried foods that uses total polar compounds (TPC) as a measure of suitability for continued frying.

[0007] Thus, there is a need for a method and system of optimizing a blending
15 formulation of an edible oil sample, thereby addressing at least the problems mentioned hereinabove and complying with constraints imposed on frying oil parameters provided by industry needs.

Summary

[0008] According to an embodiment, a method for optimizing a blending formulation of
20 an edible oil sample is provided. The method may include receiving a dataset of values representing at least one type of index obtained from a plurality of pure oils and/or oil blends, and generating a prediction of the optimized blending formulation from the received dataset of values, wherein the step of generating the prediction of the optimized
25 blending formulation comprises using a predictive model configured to generate a plurality of blending formulations based on the received dataset of values, evaluate at least one index value of each of the plurality of blending formulations and compare the evaluated at least one index value with at least one predefined threshold value to determine the optimized blending formulation from the generated plurality of blending
30 formulations, the at least one predefined threshold value and the at least one index value

being of the same type of index, and the at least one predefined threshold value being industrially approved.

[0009] According to an embodiment, an edible oil sample predicted using a method in accordance with various embodiments is provided.

5 [0010] According to an embodiment, a computer readable storage medium including computer readable instructions operable when executed by a computer to optimize a blending formulation of an edible oil sample is provided. The computer readable instructions may be configured to perform a method in accordance with various embodiments.

10 [0011] According to an embodiment, an apparatus or system is provided. The apparatus or system may include a receiving unit configured to receive a dataset of values representing at least one type of index obtained from a plurality of pure oils and/or oil blends; a memory for storing a prediction model, wherein a predictive model configured to generate a plurality of blending formulations based on the received dataset of values,
15 evaluate at least one index value of each of the plurality of blending formulations and compare the evaluated at least one index value with at least one predefined threshold value to determine the optimized blending formulation from the generated plurality of blending formulations, the at least one predefined threshold value and the at least one index value being of the same type of index, and the at least one predefined threshold
20 value being industrially approved; and a processor configured to access the prediction model stored in the memory to perform steps of a method in accordance with various embodiments for generating a prediction of an optimized blending formulation of an edible oil sample.

25 Brief Description of the Drawings

[0012] In the drawings, like reference characters generally refer to like parts throughout the different views. The drawings are not necessarily to scale, emphasis instead generally being placed upon illustrating the principles of the invention. In the following
30 description, various embodiments of the invention are described with reference to the following drawings, in which:

[0013] FIG. 1A shows a flow chart illustrating a method for optimizing a blending formulation of an edible oil sample, according to various embodiments.

[0014] FIG. 1B shows a schematic view of an apparatus or system 120 for optimizing a blending formulation of an edible oil sample, according to various embodiments.

5 [0015] FIG. 2A shows a schematic flow chart illustrating an overview method for designing or optimizing an edible oil blend, according to various embodiments.

[0016] FIG. 2B shows a flow chart illustrating a workflow of a genetic algorithm, according to various embodiments.

10 [0017] FIG. 3A shows a graph illustrating the performance of different types of pure oil in frying.

[0018] FIG. 3B shows a representative schematic of pure oils as in FIG. 3A with indications of the respective frying life, saturated fatty acid content, and price, according to various examples.

15 [0019] FIG. 4A shows a graph illustrating experimentally measured TPC values of blended oils conforming to the predicted frying performance, according to various embodiments.

[0020] FIG. 4B shows a graph illustrating experimentally measured TPC values of blended oils, with palm oil being used as positive control and negative controls, according to various embodiments.

20 [0021] FIG. 4C shows a graph illustrating a relationship between acid values of blended oils and time, compared against controls, according to various embodiments.

[0022] FIGS. 5A to 5I show graphs illustrating the relationship between different oxidation indexes, according to various embodiments.

25 Detailed Description

[0023] The following detailed description refers to the accompanying drawings that show, by way of illustration, specific details and embodiments in which the invention may be practiced. These embodiments are described in sufficient detail to enable those
30 skilled in the art to practice the invention. Other embodiments may be utilized and changes may be made without departing from the scope of the invention. The various

embodiments are not necessarily mutually exclusive, as some embodiments can be combined with one or more other embodiments to form new embodiments.

[0024] Embodiments described in the context of one of the methods or devices are analogously valid for the other methods or devices/apparatus. Similarly, embodiments described in the context of a method are analogously valid for a device, and vice versa.

[0025] Features that are described in the context of an embodiment may correspondingly be applicable to the same or similar features in the other embodiments. Features that are described in the context of an embodiment may correspondingly be applicable to the other embodiments, even if not explicitly described in these other embodiments.

Furthermore, additions and/or combinations and/or alternatives as described for a feature in the context of an embodiment may correspondingly be applicable to the same or similar feature in the other embodiments.

[0026] In the context of various embodiments, the articles “a”, “an” and “the” as used with regard to a feature or element include a reference to one or more of the features or elements.

[0027] In the context of various embodiments, the phrase “substantially” may include “exactly” and a reasonable variance.

[0028] In the context of various embodiments, the term “about” or “approximately” as applied to a numeric value encompasses the exact value and a reasonable variance.

[0029] As used herein, the term “and/or” includes any and all combinations of one or more of the associated listed items.

[0030] As used herein, the phrase of the form of “at least one of A or B” may include A or B or both A and B. Correspondingly, the phrase of the form of “at least one of A or B or C”, or including further listed items, may include any and all combinations of one or more of the associated listed items.

[0031] Various embodiments may provide a method and system for optimizing an edible oil blend.

[0032] The method for optimizing edible oil blends and an apparatus or system therefor in accordance with various embodiments may further provide formulas of oil blends, especially frying oil blends, that suffice several criteria. For example, one or more oil blends may be provided

[0033] The method may include receiving fatty acid composition, price of pure oils and/or oil blends and total polar compound (TPC) values of pure oils and/or oil blends over a heating period of 24 hours; providing a prediction model capable of generating at least one blended oil.

5 [0034] The apparatus or system may include a receiving unit configured to receive fatty acid composition, price of pure oils and/or oil blends, and/or TPC values of pure oils and/or oil blends over a heating period, such as 24 hours; a memory for storing a prediction model capable of generating a prediction of optimized oil blends; and a processor configured to access the prediction model stored in the memory to perform
10 steps of the method in accordance with various embodiments for generating a prediction of an optimized blended oil, such as frying oil, in accordance with various embodiments for generating a formulation of oil blends.

[0035] FIG. 1A shows a flow chart illustrating a method for optimizing a blending formulation of an edible oil sample 100, according to various embodiments. In FIG. 1A,
15 at Step 102, a dataset of values representing at least one type of index obtained from a plurality of pure oils and/or oil blends is received. At Step 104, a prediction of the optimized blending formulation is generated from the received dataset of values.

[0036] The method 100 may further include generating a prediction of a parameter of the optimized blending formulation of the edible oil sample.

20 [0037] In other words, the method 100 may be a method of predicting an optimized blending formulation of the edible oil sample by using a predictive model that processes data values representing one or more indices of a plurality of pure oils and/or oil blends in the prediction(s). The parameter of the optimized blending formulation may also be predicted using the predictive model.

25 [0038] In various embodiments, the predicted parameter may be representative of a predicted post-blend behavior over a specific time frame. The predicted parameter may also be indicative of a quality level of the edible oil sample. For example, the parameter may include a frying life of the optimized blending formulation. The frying life may be validated by conducting lab experiments.

30 [0039] In various embodiments, the step of generating the prediction of the optimized blending formulation at Step 104 may include using the predictive model configured to

generate a plurality of blending formulations based on the received dataset of values, evaluate at least one index value of each of the plurality of blending formulations and compare the evaluated at least one index value with at least one predefined threshold value to determine the optimized blending formulation from the generated plurality of blending formulations. The at least one predefined threshold value and the at least one index value may be of the same type of index. The at least one predefined threshold value may be industrially approved. For example, the at least one predefined threshold value may be an industrial-standard value or industrially recommended value.

[0040] In various embodiments, the predictive model may be a genetic model constructed from at least one vector of features. Each feature may correspond to an initial index value obtained from a specific pure oil or oil blend of the plurality of pure oils and/or oil blends, or an index value of the at least one index value. The initial index value may include at least one of a frying life of the specific pure oil or oil blend, a fatty acid content of the specific pure oil or oil blend, a price of the specific pure oil or oil blend, and a total polar compound (TPC) value generated by the specific pure oil or oil blend during cooking. In other words, the prediction model may be optimized by the at least one vector of features, or when there is more than one vector, a matrix of features. The index value of the at least one index value may be based on data examples, which may include at least one of a frying life of a predicted oil blend, a fatty acid content of the predicted oil blend, a price of the predicted oil blend, and a total polar compound (TPC) value generated by the predicted oil blend during cooking.

[0041] The predictive model may be based on a non-hybridized, standalone genetic algorithm. In various embodiments, the genetic model may include an input portion configured to receive the dataset of values, a genetic algorithm configured to determine a fittest blending formulation based on an objective function, and an output portion comprising multiple outputs configured to present the fittest blending formulation as the optimized blending formulation. The genetic algorithm may be further configured to evaluate the parameter of the optimized blending formulation, and the multiple outputs may be further configured to substantially simultaneously present the parameter at the output portion.

[0042] In various embodiments, the at least one type of index may be indicative of a characteristic of the plurality of pure oils and/or oil blends. For example, the type of index may include an oxidation index, or a nutritional index, or a market index.

5 [0043] The oxidation index may include a total polar compound (TPC) value, or a frying life, or an anisidine value, or a carbonyl value, or a thiobarbituric acid level, or a conjugated dienes acid value, or a conjugated trienes acid value, or a combinational value of conjugated dienes acid and conjugated trienes acid, or a polyunsaturated fatty acids content decrease, a polymer by-product value. For example, the TPC value may refer to a TPC value over a heating period of 24 hours.

10 [0044] The nutritional index may include a fatty acid content, or a structured lipid level.

[0045] The market index may include a price. It should be appreciated and understood that prices shown in Table 2 below serve only as an example and should not be interpreted in a limiting sense.

15 [0046] For example, the optimized blending formulation may satisfy at least one of the following requirements:-

- (i) lowest price;
- (ii) constraint imposed by the at least one predefined threshold value; and
- (iii) longest frying life.

20 [0047] In other words, the optimized blending formulation may have a lowest price, or may conform to a constraint imposed by the at least one predefined threshold value, or may have a longest frying life, or any combinations thereof.

25 [0048] In various embodiments, the method 100 may further include generating the dataset of values. The step of generating the dataset of values may include performing a linear combination of first index values obtained from a plurality of pure oils and/or oil blends to form a landscape comprising second index values of the plurality of pure oils and/or oil blends; applying a sampling algorithm to the landscape to sample from the second index values; and forming at least part of the dataset of values based on the sampled second index values. The first index values and the second index values are of the at least one type of index, or may be based on the same type of index.

30 [0049] For example, the sampling algorithm may be based on a Dirichlet distribution.

[0050] The step of generating the dataset of values may be performed before Step 102.

[0051] In various embodiments, the step of receiving the dataset of values representing at least one type of index obtained from the plurality of pure oils and/or oil blends at Step 102 may include receiving the dataset of values representing more than one type of index obtained from the plurality of pure oils and/or oil blends, wherein the more than one type of index includes an oxidation value and a nutritional index, or an oxidation value and a nutritional index and a market index.

[0052] The step of generating the prediction at Step 104 and the step of generating the prediction of the parameter of the optimized blending formulation may be in real-time.

[0053] While the method described above is illustrated and described as a series of steps or events, it will be appreciated that any ordering of such steps or events are not to be interpreted in a limiting sense. For example, some steps may occur in different orders and/or concurrently with other steps or events apart from those illustrated and/or described herein. In addition, not all illustrated steps may be required to implement one or more aspects or embodiments described herein. Also, one or more of the steps depicted herein may be carried out in one or more separate acts and/or phases.

[0054] Various embodiments may provide an edible oil sample predicted using the method 100, in accordance to various embodiments. The edible oil sample may be a blended oil or a blended frying oil or a blended flavoured oil.

[0055] Various embodiments may further provide a computer readable storage medium including computer readable instructions operable when executed by a computer to optimize a blending formulation of an edible oil sample. The computer readable instructions configured to perform the method 100, in accordance with various embodiments and/or as described herein.

[0056] FIG. 1B shows a schematic view of an apparatus or system 120 for optimizing a blending formulation of an edible oil sample, according to various embodiments. In FIG. 1B, the apparatus or system 120 includes a receiving unit 122 configured to receive a dataset of values representing at least one type of index obtained from a plurality of pure oils and/or oil blends; a memory 124 for storing a prediction model; and a processor 126 configured to access the prediction model stored in the memory 124 to perform steps of the method 100 (FIG. 1A) for generating a prediction of an optimized blending formulation of an edible oil sample. The processor 126 may be further configured to

access the prediction model stored in the memory 124 to perform steps of the method 100 for further generating a prediction of a parameter of the optimized blending formulation of the edible oil sample. The predicted parameter may be representative of a predicted post-blend behavior over a specific time frame, or may also be indicative of a quality level of the edible oil sample.

[0057] The receiving unit 122, the memory 124 and the processor 126 may be in communication with one another, as depicted by lines 128, 130. The communication may be bi-directional.

[0058] The apparatus or system 120 may include the same or like elements or components as those described in the method 100 of FIG. 1A, and as such, the like elements may be as described in the context of the method 100 of FIG. 1A, and therefore the corresponding descriptions are omitted here.

[0059] In various embodiments, the apparatus or system 120 may further include a pre-processor unit configured to perform a linear combination of first index values obtained from a plurality of pure oils and/or oil blends to form a landscape comprising second index values of the plurality of pure oils and/or oil blends, and to apply a sampling algorithm to the landscape to sample from the second index values to form at least part of the dataset of values based on the sampled second index values. The first index values and the second index values are of the at least one type of index.

[0060] For example, the pre-processor unit may form an integral part of the processor, and the memory may further be configured to store the sampling algorithm.

[0061] Examples will be described below in forms of experiments conducted to provide a better understanding of the method 100 and the apparatus or system 120.

[0062] Design or optimization of oil blends for various cooking purpose is a difficult task. Various embodiments may provide an application of integrating deep-learning and various lab technologies in the cooking oil field to design and optimize oil blends.

[0063] FIG. 2A shows a schematic flow chart 200 illustrating an overview method for designing or optimizing an edible oil blend 208, in accordance with various embodiments. The method includes steps 201, 202 and/or 203 and/or 204, 205, 206, and 207.

[0064] The overview method of FIG. 2A may be described in similar context with the method 100 of FIG. 1A.

[0065] In FIG. 2A, at step 201 the raw data including the fatty acid composition of pure oils and/or oil blends, the price of pure oils and/or oil blends and the total polar compound (TPC) values of pure oils and/or oil blends over a heating period of 24 hours is taken in as input to the algorithm.

[0066] FIG. 3A shows a graph 300 illustrating the performance of different types of pure oil in frying. “Value” stands for the percentage of TPC generated after heating the oil for approximately 24 hours. “Time” is in hours. A linear model was used to estimate TPC values over frying time. The frying life is determined as the amount of time required for an oil to reach a TPC value of 27 %, which is generally regarded as the cutoff for an unhealthy frying oil. In context of various examples, RSO stands for rapeseed oil; RBO stands for rice bran oil; POL stands for palm oil; SFO stands for sunflower oil, HOSFO stands for high oleic sunflower oil; SBO stands for soybean oil; MZO stands for maize oil (corn oil).

[0067] FIG. 3B shows a representative schematic of pure oils (in bottles) with indications of the respective frying life in hours (i.e. the hours that the oil is heated at 180 °C to reach a TPC of 27 %), the respective saturated fatty acid content (SFA) in percentage, and the price in Chinese Yuan currency (CNY). It should be appreciated that the cutoff for temperature and TPC should not be interpreted in a limited sense. Oils that have a value of below 8,000 CNY/MT (Chinese Yuan/Metric ton) have low frying life below 20 hours and generally low SFA. Oils that fry for a longer period of time above 20 hours have much higher prices of about 14,000 CNY/MT. For example, palm oil has relatively long frying life of 25 hours, and it is relatively cheap. However, palm oil has a very high SFA of 44%.

[0068] The aim of the method as described in FIG. 2A is to determine a blended oil “B” (as indicated in FIG. 3B) and the frying life, SFA and price thereof.

[0069] Referring to FIG. 2A, at step 202, the space of pure oils and/or blend oils is evaluated with respect to price. A sampling algorithm based on the Dirichlet distribution was used to survey the landscape of prices as linear combinations of pure oil prices and/or blended oil prices. The figure at 202 shows the price space of possibilities, where

bright regions indicate high priced blends and dark regions indicate low priced blends. At step 203, the space of fatty acid composition (FAC) is evaluated for all pure oils and/or oil blends. A sampling algorithm based on the Dirichlet distribution was used to survey the landscape of FAC as linear combinations of fatty acid composition of pure oils and/or blended oils. The figure at 203 shows bright regions representing blends with high saturated fatty acids and dark regions representing blends with low saturated fatty acids. It should be appreciated that other types of fatty acids, e.g. monounsaturated, polyunsaturated, n-3 and n-6 fatty acids may also be evaluated at this step. At step 204, the TPC values of pure oils and/or oil blends over a heating time over 24 hours was first fitted on a linear model to estimate the frying life defined as the amount of time required for an oil to reach a TPC value of 27. This may be easily estimated from the linear model. Following this, the space of pure oils and/or blended oils is evaluated with respect to frying life. A sampling algorithm based on the Dirichlet distribution was used to survey the landscape of frying life as linear combinations of the frying life of pure oils and/or blended oils. The figure at 204 shows bright regions representing blends with high frying life and dark regions representing blends with low frying life.

[0070] The sampling algorithm was employed to enable sampling of the search space, which is typically large as shown in the figures at 202, 203 and 204 and may conflict with one another, e.g. low price correlate with undesirable saturated fat content.

[0071] At step 205, the subsample of blends in 202, 203 and 204 was evaluated for meeting industry requirements such as controlled saturated fatty acid (SFA), medium chain unsaturated fatty acid (MUFA) and polyunsaturated fatty acid (PUFA) percentages. Constraints around the frying oil parameters are provided by industry needs. In other words, initial suggestions that fit constraints around the frying oil parameters that are provided by industry needs may be obtained by sampling the search space. For example, SFA is commonly regarded bad or unhealthy, while the MUFA:PUFA ratio is also important for nutritional balance. Some fatty acids confer unfavorable flavor and may also be controlled. Frying life may be controlled by monitoring TPC of the blends.

[0072] The blends at 205 may meet the requirements but are not optimal with respect to price differential. However, the blends at 205 may provide a starting point for optimization.

[0073] Data at 202-206 is used as inputs to a genetic algorithm at 207 to find the fittest blended oil based on an objective function that combines the qualities of price, SFA, MUFA, PUFA and frying life. The fittest blend at 208 and as mentioned herein refers to the blend that has lowest price, meets SFA/MUFA/PUFA requirements and has the longest frying life.

[0074] In other words, additional improvements to oil formulation (e.g. blends at 205) are optimized based on the genetic algorithm (e.g., 207) that mutates each formula iteratively to find the best solution over successive generations. The best solution may also preserve the longest frying quality across the generations and is indicated by time taken to reach a high TPC value. This may be verified by experiments or, for example, by a separate deep learning NIR (near infrared) model for rapid testing.

[0075] The genetic algorithm (e.g., 207) may work based on a workflow 220 as shown in a flow chart of FIG. 2B. As seen in FIG. 2B, in a general way, the workflow 220 may start with an initial population 222. At 224, the fitness of the population that may include the initial population 222 and/or a new population generated 232 may be determined by using an objective function, which will be described in more details below. A selection and a crossover of mates may be performed at 226 and 228, respectively. This may be followed by mutation at 230 which then creates the new population 232. If the new population 232 does not meet a stopping criteria 234, the new population 232 may be feedback to the fitness step at 224. The process may continue until an eventual new population 232 meets the stopping criteria 234, and a result 236 (in this case, a predicted blending formulation) may be obtained.

[0076] The method as described in FIGS. 1A and 2A may be a method of designing or optimizing more than one edible oil blend. In other words, modeling of multiple oil blends outcomes may be provided in one single model.

[0077] The prediction model, or interchangeably referred to as genetic model, may utilize the objective function in which a formula reflects the fittest of a blended oil, where the higher the fittest value, the closer it is to the most optimal blend represented by having the lowest cost, meeting fatty acid requirements and bearing the longest frying life. More specifically, the model evaluates generations of blends, where the initial population may be constructed by suggestions (e.g. based on 202-204 of FIG. 2A). At each generation,

the fittest blends evaluated based on a formula that reflects the lowest price, meets SFA/MUFA/PUFA constraints and has the longest frying life is allowed to propagate into the next generation, where blend ratios are slightly mutated and allowed to produce offsprings from the fittest blends in the previous generation. Offsprings here refer to blends that are a mixture of two parental blends. At the n th generation, the model may identify the most optimal blend based on the defined objective function.

[0078] The objective function may include a number of parts which has to be optimized.

[0079] The total cost of the blended oil formula may have to be minimized by using Equation 1, where the cost of each oil type may be predefined:

$$\min C(x_i) = \sum_{i=1}^N c_i x_i$$

10

- Equation 1

[0080] The saturated fats may need to be minimized by using Equation 2:

$$\min S(x_i) = \sum_{i=1}^N s_i x_i$$

- Equation 2

[0081] The mono unsaturated fats may need to be maximized by using Equation 3:

$$\max M(x_i) = \sum_{i=1}^N m_i x_i$$

- Equation 3

15 [0082] The poly unsaturated fats may need to be minimized by using Equation 4:

$$\min P(x_i) = \sum_{i=1}^N p_i x_i$$

- Equation 4

[0083] The c18:3 fatty acid that contribute to unpleasant frying taste may be minimized by using Equation 5:

$$\min Y(x_i) = \sum_{i=1}^N y_i x_i$$

- Equation 5

[0084] The frying life defined to be the time taken to reach a TPC value of 27% may need to be maximized by using Equation 6, where ψ_i^1 and ψ_i^2 represent different TPC-related indices:

$$\max \Psi(x_i) = \sum_{i=1}^N \frac{27 - \psi_i^1 x_i}{\psi_i^2}$$

- Equation 6

5 [0085] In each of Equations 1 to 6, N represents a total number of oil types and x represents a feature corresponding to an initial index value obtained from a specific pure oil or oil blend, or an index value obtained from a predicted blending formulation. For example, the initial index value may include at least one of a frying life of the specific
10 pure oil or oil blend, a fatty acid content of the specific pure oil or oil blend, a price of the specific pure oil or oil blend, and a total polar compound (TPC) value generated by the specific pure oil or oil blend during cooking, while the index value may include at least one of a frying life of a predicted oil blend, a fatty acid content of the predicted oil blend, a price of the predicted oil blend, and a total polar compound (TPC) value generated by
15 the predicted oil blend during cooking. It should be appreciated and understood that initial index values may change with time, which were described herein as an example.

[0086] Depending on the requirements, the boundary constraints may be modified. Boundary condition for fats may be, for example, $S(x_i) < 25$, $M(x_i) < 50$, $P(x_i) < 25$. In other example, boundary condition for inventory samples may be that the total amount of oil
20 used scaled from the blend proportions meets the inventory amount. These boundary conditions may be subject to change with fluctuation of oil prices, which are described herein as an example. It should be appreciated and understood that other boundary conditions may be considered and may also be subject to change with fluctuation of oil prices, even though these are not described here.

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Experiment Set I

[0087] Frying oil formulations obtained by running the genetic model described above are characterized in Table 1 and:

- (i) the percentage for each oil type may vary in a range of 5 wt%, 4 wt%, 3 wt%, 2 wt%, 1 wt%, 0.5 wt% or 0.1 wt%; and/or
- (ii) the formulations may satisfy criterias set out to meet industrial needs.

[0088] In one embodiment, the characteristics of formulations optimized are shown in Table 1 below, where B1 to B4 refer to four different blending formulations of oils.

[0089] Table 1

(per 100g)	POL	RSO	HOSFO	B1	B2	B3	B4
SFA	44	7	8	21.8	18.9	14.7	15.1
C14:0	0.84	0	0.24	0.29	0.27	0.17	0.19
C16:0	38.04	4.07	3.96	16.21	15.08	11.27	11.47
C18:0	4.84	1.8	2.93	2.91	2.81	2.43	2.51
C20:0	0	0	0	0.08	0.11	0.11	0.03
C22:0	0	0	0	0.08	0.11	0.08	0.09
MUFA	44	65	84	54.45	55.28	56.71	60.36
C16:1	0.3	0	0	0.11	0.09	0.07	0.06
C18:1	43.2	61.81	83.34	52.43	53.29	54.43	58.05
C20:1	0	1.64	0	0.86	0.85	1.06	1.08
PUFA	12	28	8	25.33	25.73	28.5	24.53
C18:2	10.9	18.53	6.7	19.97	20.41	22.14	18.06
C18:3	0.7	7.59	0.12	4.21	4.15	5.02	5.08
Ω-3 Fatty Acid	0.7	7.59	0.12	4.21	4.15	5.02	5.08
Frying Life	25 h	27 h	28 h	25.5 h	25 h	25.1 h	26.2 h
Price	5,100	8,080	14,000	6,914	7,446	7,508	7,922
	CNY	CNY	CNY	CNY	CNY	CNY	CNY

[0090] The blending formulations of B1 to B4 compared against negative controls N1 to N6 are presented in Table 2 below, along with the amount of each oil component in each oil blend, and the blend price (in CNY/MT), SFA, MUFA, PUFA, and frying life (in hours) of each of B1 to B4 and N1 to N6. Table 2 also reflects the price (in CNY/MT) of each oil component.

[0091] Table 2

	Price	B1	B2	B3	B4	N1	N2	N3	N4	N5	N6
RSO	8050	0.517	0.48	0.63	0.644	0.034	0.137	0.032	0.036	0.111	0.132
RBO	7000	0.018	0.079	0.032	0.018	0.01	0.128	0.121	0.085	0.01	0.021
POL	5100	0.381	0.281	0.181	0.201	0.05	0.016	0.011	0.032	0.162	0.111
SFO	7800	0.015	0.029	0.006	0.007	0.36	0.13	0.096	0.228	0.091	0.11
HOSFO	14000	0.012	0.065	0.026	0.088	0.07	0.057	0.064	0.015	0.489	0.521
SBO	6850	0.023	0.034	0.073	0	0.23	0.315	0.433	0.096	0.056	0.023
MZO	7100	0.034	0.032	0.051	0.041	0.25	0.217	0.244	0.507	0.081	0.082
	Blend price	6915	7446	7492	7913	7729	7591	7500	7304	10304	10667
	SFA	0.218	0.19	0.15	0.151	0.14	0.135	0.142	0.146	0.151	0.134
	MUFA	0.544	0.553	0.566	0.603	0.36	0.407	0.378	0.337	0.608	0.626
	PUFA	0.238	0.257	0.282	0.245	0.5	0.458	0.48	0.516	0.241	0.240
	Life	25.5	25	25	26	19.4	19.7	18.8	18.8	26	26.5

[0092] Lab experiments were carried out to examine the frying performance of formulations B1, B2, B3, and B4. The results are shown in FIG 4A. FIG. 4A shows a graph 400 illustrating the experimentally measured TPC values of blended oils (B1 to B4) conforming to the predicted frying performance. Palm oil was used as control. Heating time is correlated with frying time.

[0093] As seen in FIG. 4A, the formulations B1, B2, B3, and B4 exhibit similar frying performance to palm oil, which form a better basis compared with other blends in the prior art. This demonstrates that the model is able to find similar performing blends with much lower price. FIG. 4B shows a graph 402 illustrating the experimentally measured TPC values of blended oils (B1 to B4), with negative controls (N1 to N6). Formulas were calculated with the model and TPC that are observed to be growing faster were chosen randomly to provide N1 to N6. FIG. 4C shows a graph 404 illustrating a relationship between acid values of blended oils (B1 to B4) and heating time, with N1 to N6 as control. B1-B4 are observed to perform substantively similar to palm oil, and display superior performances to N1-N4, which have shorter pot lives. B1-B4 are also observed to perform similar to N5-N6, with lower price. FIG 4B and FIG 4C are based on experimental results.

Experiment Set II

[0094] Instead of using the total polar compound (TPC) values of pure oils and/or blended oils (e.g. at 201 of FIG. 2A), a different oxidation index, for example, acid value (AC), peroxide value (PV), p-anisidine value (PAV), colour (COL), conjugated diene

(CD), conjugated triene (CT), viscosity, carbonyls, polymer (or polymer by-product) and oxidation stability index (OSI) may be considered.

[0095] The basis for extending the use of a different oxidation index lies in the linear relationships found among the different oxidation indexes. For example, in a frying test, the relationships between the different oxidation indexes were evaluated. FIG. 5A shows a graph illustrating the relationship between carbonyl and polymer by-product, FIG. 5B shows a graph illustrating the relationship between PAV and polymer by-product, FIG. 5C shows a graph illustrating the relationship between TPC and AC, FIG. 5D shows a graph illustrating the relationship between polymer and AC, FIG. 5E shows a graph illustrating the relationship between viscosity and AC, FIG. 5F shows a graph illustrating the relationship between CD and PAV, FIG. 5G shows a graph illustrating the relationship between CD and carbonyl, FIG. 5H shows a graph illustrating the relationship between CD and polymer, and FIG. 5I shows a graph illustrating the relationship between OSI and TPC.

[0096] Table 3 shows the linearly dependent regression coefficient (R^2) of the different oxidation indexes based on FIGS. 5A to 5I.

[0097] Table 3

	<i>p</i> -anisidine value	carbonyl value (meq/Kg)	AV (mgKOH/g)	PC (%)	Viscosity (mm ² /S)	Polymer (%)	CD
<i>p</i> -anisidine value	—	—	—	—	—	—	—
carbonyl value (meq/Kg)	0.977	—	—	—	—	—	—
AV (mgKOH/g)	0.940	0.988	—	—	—	—	—
PC (%)	0.933	0.981	0.986	—	—	—	—
Viscosity (mm ² /S)	0.918	0.975	0.996	0.986	—	—	—
Polymer (%)	0.991	0.994	0.969	0.969	0.953	—	—
CD	0.993	0.993	0.969	0.965	0.954	0.999	—

[0098] Experiments were further carried out based on soybean oil and oil blends with consideration of different oxidation indexes. The following frying test results in Tables 4 to 6 show that there is a linear correlation between the various oxidation indicators in the actual frying process, not only in pure oil, but also in blended frying oil. Therefore, any one oxidation index or a combination of multiple oxidation indices may be used in the

present invention to characterize the degree of oxidation. Using the model of the present invention, different pure oils may be blended and optimized, and the initial semi-finished blended oil may also be optimized to blend with other pure oils or other blended oils to obtain the optimized blended oil. Taking into account different oxidation indexes, further experiments were carried out based on soybean oil and blended oil.

[0099] Table 4 shows different oxidation indexes for soybean oil when used to cook fries, noodle, chicken wing and noodle (with oil top up).

[0100] Table 4

sample	frying day	AV [mgKOH/g]	PV [mmol/g]	COL (25.4mm, Red)	PAV	TPC (%)	CD	CT	viscosity [@40°C] [mm ² /s]	carbonols	polymer [%]
Fries											
NBDSBO-fries-1-0	0	0.05	0.04	0.1	3.48	8.0	4.60	1.81	31.547	9.45	1.17
NBDSBO-fries-1-1	1	0.09	1.09	0.3	47.05	10.0	7.01	2.53	32.756	18.97	2.42
NBDSBO-fries-1-2	2	0.14	1.80	0.7	75.34	12.0	9.75	3.59	34.327	28.22	4.39
NBDSBO-fries-1-3	3	0.17	1.31	0.5	90.93	13.0	10.85	3.84	35.731	32.56	5.71
NBDSBO-fries-1-4	4	0.21	1.30	1.2	103.74	14.0	12.43	4.12	36.275	37.59	7.23
NBDSBO-fries-1-5	5	0.26	0.73	1.6	118.06	15.0	13.44	4.33	36.868	39.81	8.49
NBDSBO-fries-1-6	6	0.41	1.09	3.1	129.07	17.5	16.45	4.58	38.525	47.78	10.35
NBDSBO-fries-1-7	7	0.46	0.67	4.1	133.68	18.5	17.66	4.70	41.197	51.86	12.25
NBDSBO-fries-1-8	8	0.54	1.04	5.3	134.91	23.0	19.40	4.66	42.742	56.09	13.81
NBDSBO-fries-1-9	9	0.60	1.37	6.5	135.30	25.0	20.33	4.89	45.088	58.92	15.78
NBDSBO-fries-1-10	10	0.72	1.55	10.0	136.74	28.0	21.50	4.80	49.119	69.40	19.93
NBDSBO-fries-2-0	0	0.05	0.04	0.1	3.58	7.5	4.47	1.80	31.562	9.41	1.21
NBDSBO-fries-2-1	1	0.10	1.08	0.3	47.78	10.5	7.01	3.00	32.635	20.22	2.61
NBDSBO-fries-2-2	2	0.15	1.84	0.8	78.95	12.0	9.73	3.76	34.125	28.99	4.19
NBDSBO-fries-2-3	3	0.18	1.75	1.1	88.99	13.0	11.40	4.19	35.628	34.52	5.67
NBDSBO-fries-2-4	4	0.22	1.74	1.6	111.57	14.0	12.70	4.40	36.477	38.98	7.59
NBDSBO-fries-2-5	5	0.27	1.09	2.2	129.38	16.5	15.04	5.05	37.211	44.57	8.33
NBDSBO-fries-2-6	6	0.45	1.28	4.1	134.54	18.0	17.26	4.91	40.65	47.83	10.85
NBDSBO-fries-2-7	7	0.48	1.14	5.5	134.67	19.5	18.31	4.69	41.621	51.79	12.72
NBDSBO-fries-2-8	8	0.56	1.20	6.7	136.51	23.5	19.04	5.13	43.315	56.40	13.59
NBDSBO-fries-2-9	9	0.65	1.47	8.3	139.12	25.5	22.65	5.50	45.878	60.25	15.48
NBDSBO-fries-2-10	10	0.74	1.48	12.0	143.61	28.5	23.34	5.66	50.444	66.63	20.28
Noodle											
NBDSBO-noodle-1-1	0	0.08	1.95	0.4	89.12	9.5	9.31	4.29	33.483	30.42	4.77
NBDSBO-noodle-1-2	1	0.11	1.78	0.5	142.72	14.5	13.30	5.08	35.436	46.37	8.11
NBDSBO-noodle-1-3	2	0.19	1.95	1.3	258.56	28.0	22.22	9.19	42.063	51.32	14.77
NBDSBO-noodle-1-4	3	0.23	2.03	1.8	288.98	34.0	24.93	9.67	45.387	112.89	18.22
NBDSBO-noodle-1-5	4	0.29	2.25	2.2	333.07	> 40	29.18	10.35	52.131	131.69	20.02
NBDSBO-noodle-2-1	0	0.10	3.21	0.5	152.16	9.5	10.26	4.70	33.883	34.62	5.58
NBDSBO-noodle-2-2	1	0.12	2.09	0.7	154.13	16.0	14.88	6.75	36.392	57.14	9.32
NBDSBO-noodle-2-3	2	0.19	1.65	1.4	244.42	26.5	21.00	8.80	41.523	75.83	14.76
NBDSBO-noodle-2-4	3	0.25	1.65	1.8	254.39	33.0	24.15	9.63	44.613	195.81	17.37
NBDSBO-noodle-2-5	4	0.31	2.55	2.2	315.25	40.0	27.53	10.19	49.291	125.43	20.68
Chicken Wing											
NBDSBOCW-1-1	0	0.12	1.74	0.8	65.94	8.9	8.08	3.12	33.864	22.22	3.82
NBDSBOCW-1-2	1	0.21	1.50	2.2	122.61	12.5	12.39	4.04	36.531	36.31	5.00
NBDSBOCW-1-3	2	0.33	1.62	5.5	166.79	18.5	17.06	4.77	40.086	50.97	12.67
NBDSBOCW-1-4	3	0.41	1.40	7.0	181.29	23.5	19.35	5.04	43.406	58.34	13.22
NBDSBOCW-1-5	4	0.54	1.58	10.2	192.10	27.0	21.49	5.20	48.127	68.78	18.40
NBDSBOCW-1-6	5	0.66	1.50	13.1	200.52	33.0	23.28	5.32	52.569	77.39	21.04
NBDSBOCW-2-1	0	0.12	2.30	0.8	88.21	8.5	5.52	3.59	34.241	26.36	5.31
NBDSBOCW-2-2	1	0.21	1.89	2.5	135.00	13.5	13.65	4.47	36.601	40.63	9.11
NBDSBOCW-2-3	2	0.33	1.80	4.9	173.33	19.5	17.73	5.02	40.361	52.20	12.98
NBDSBOCW-2-4	3	0.44	1.78	6.8	187.54	23.5	19.76	5.16	43.899	61.78	15.72
NBDSBOCW-2-5	4	0.54	1.98	10.0	195.35	28.5	21.65	5.29	48.189	70.08	18.58
NBDSBOCW-2-6	5	0.62	1.78	13.0	203.65	32.5	23.64	5.43	52.749	76.74	20.94

Noodle, oil top up (Add new oil):											
NBDSBO-noodle-1-0	0	0.07	0.74	0.1	2.19	2.5	4.58	1.81	31.739	7.89	
(Add new oil):											
NBDSBO-noodle-1-1	1	0.10	2.91	0.2	79.50	7.0	9.13	3.02	35.911	23.98	1.19
(Add new oil):											
NBDSBO-noodle-1-2	2	0.15	3.12	0.4	133.58	11.5	13.66	3.96	36.433	37.72	4.86
(Add new oil):											
NBDSBO-noodle-1-3	3	0.17	3.31	0.5	173.52	16.0	17.91	4.80	35.07	49.62	5.80
(Add new oil):											
NBDSBO-noodle-1-4	4	0.21	2.42	0.6	158.85	20.0	20.26	5.01	41.366	57.79	11.83
(Add new oil):											
NBDSBO-noodle-1-5	5	0.23	2.45	0.7	201.88	21.5	20.61	5.12	42.653	61.63	14.57
(Add new oil):											
NBDSBO-noodle-1-6	6	0.26	2.59	0.8	272.21	28.0	23.44	5.44	45.784	71.57	15.97
(Add new oil):											
NBDSBO-noodle-2-0	0	0.07	0.71	0.1	2.23	2.5	4.64	1.83	31.739	8.10	
(Add new oil):											
NBDSBO-noodle-2-1	1	0.10	2.60	0.2	75.87	7.0	9.37	3.10	33.785	23.71	1.26
(Add new oil):											
NBDSBO-noodle-2-2	2	0.13	2.90	0.4	131.81	11.5	14.02	3.98	36.472	37.65	4.24
(Add new oil):											
NBDSBO-noodle-2-3	3	0.18	2.82	0.5	172.48	16.5	17.57	4.57	39.182	48.78	5.39
(Add new oil):											
NBDSBO-noodle-2-4	4	0.21	2.54	0.6	197.70	20.5	20.17	5.00	41.566	57.40	11.80
(Add new oil):											
NBDSBO-noodle-2-5	5	0.23	2.72	0.7	251.21	21.5	20.73	5.01	42.743	60.60	14.72
(Add new oil):											
NBDSBO-noodle-2-6	6	0.27	2.10	0.8	228.94	27.5	25.55	6.00	46.639	75.87	15.57

[0101] Table 5 shows different oxidation indexes for oil blends.

[0102] Table 5

sample	frying time [day]	AV (mgKOH/g)	PV (mmol/kg)	COL [25.4mm, Red]	PAV	TPC (%)	CO	CT	viscosity (mm ² /s)	carbonols	polymer (%)
NPCYB-1-0	0	0.09	0.19	0.2	2.47	7.00	4.05	1.65	33.230	7.4	1.244
NPCYB-1-1	1	0.14	0.5	0.5	20.19	8.50	5.55	2.20	33.591	12.51	2.248
NPCYB-1-2	2	0.17	0.54	0.9	38.38	9.50	6.33	2.44	34.236	14.91	3.166
NPCYB-1-3	3	0.25	0.8	1.3	49.31	10.00	7.43	2.70	34.998		
NPCYB-1-4	4	0.35	0.44	1.5	69.48	11.00	8.54	3.19	35.773	23.2	4.653
NPCYB-1-5	5	0.4	1.14	2.2R	75.17	12.00	9.90	3.49	36.608		
NPCYB-1-6	6	0.48	0.99	2.3R	82.09	13.00	10.57	3.61	37.536	28.96	7.222
NPCYB-1-7	7	0.52	1.7	4.3R	95.49	14.50	12.52	3.94	38.839		
NPCYB-1-8	8	0.61	1.31	4.3R	95.59	15.00	12.85	3.95	39.624	40.01	8.665
NPCYB-1-9	9	0.65	1.4	5.2R	112.31	16.00	14.48	4.18	41.220		
NPCYB-1-10	10	0.66	1.06	7.0R	124.46	18.50	16.70	4.67	43.757	56.97	13.683
NPCYB-1-11	11	0.75	1.17	8.5	130.61	20.00	18.61	5.03	45.458		
NPCYB-1-12	12	0.72	1.17	9.1	133.78	21.50	19.55	4.96	46.633	67.21	17.065
NPCYB-1-13	13	0.67	1.59	10.0R70Y	150.65	25.00	20.76	5.46	50.878	84.76	19.243
NPCYB-1-14	14	0.64	1.81	11.1R70Y	190.67	30.00	23.21	5.86	57.268	108.35	23.546
NPCYB-2-0	0	0.09	0.18	0.2	2.40	7.00	4.10	1.66	33.339	7.13	1.079
NPCYB-2-1	1	0.14	0.5	0.5	22.84	8.00	5.44	2.09	33.881	11.46	2.067
NPCYB-2-2	2	0.17	0.54	0.9	35.63	9.25	6.47	2.40	34.346	13.18	3.058
NPCYB-2-3	3	0.25	1.04	1.4	53.69	10.00	7.75	2.90	35.148		
NPCYB-2-4	4	0.33	0.57	1.8	59.31	11.00	8.16	2.95	35.784	19.74	4.576
NPCYB-2-5	5	0.4	1.42	2.1R	71.37	12.00	9.42	3.24	36.648		
NPCYB-2-6	6	0.48	1.02	2.8R	78.66	13.00	10.40	3.45	37.419	27.2	7.002
NPCYB-2-7	7	0.52	1.81	4.2R	91.70	14.50	12.12	3.77	38.999		
NPCYB-2-8	8	0.61	1.27	4.4R	95.65	15.00	12.72	3.95	39.559	37.72	5.839
NPCYB-2-9	9	0.69	1.45	5.1R	112.33	16.00	14.08	4.16	41.240		
NPCYB-2-10	10	0.67	1.37	7.1R	121.57	18.50	16.33	4.51	43.592	54.02	13.357
NPCYB-2-11	11	0.76	1.57	8.0R70Y	130.01	19.50	17.40	4.73	45.227		
NPCYB-2-12	12	0.71	1.31	9.3R70Y	132.05	21.00	17.99	4.88	46.272	63.32	16.688
NPCYB-2-13	13	0.65	1.62	10.4R70Y	152.48	24.50	20.70	5.44	50.417	79.8	20.622
NPCYB-2-14	14	0.64	1.93	12.1R70Y	174.03	29.00	22.14	5.57	56.093	101.37	23.228

[0103] Table 6 shows different oxidation indexes, including oxidation stability index, for five other oil blend samples.

[0104] Table 6

sample	frying time /day	WT (mg/20h, g)	WT (mg/24h, g)	WT (25.0mg, hour)	WT (25.0mg, hour)	polymer	OSI 100°C hour	viscosity mm ² /s 40°C
1	0	0.08	0.53	0.2	10	N.D	5.76	36.666
	1	0.14	0.28	0.4	11.5	N.D	4.55	37.633
	2	0.18	2.7	0.9	12.5	N.D	4.37	38.809
	3	0.25	0.29	0.9	13.5	N.D	4.21	39.867
	4	0.26	2.97	1.3	14.5	4.2	4.2	41.044
	5	0.41	5.49	1.6	15.5	5.1	4.22	42.113
	6	0.43	1.67	1.5	17	6.1	4.38	42.812
	7	0.57	1.69	1.8	18	6.3	4.4	43.607
	8	0.56	1.85	2	18.5	6.3	4.82	44.357
	9	0.61	2.8	2.5	19	6.3	4.83	45.384
2	0	0.11	0.54	0.2	11	N.D	6.15	34.52
	1	0.14	3.33	0.3	13	N.D	5.63	36.32
	2	0.18	3.22	0.5	14	N.D	5.47	37.55
	3	0.2	0.67	0.9	15	3.7	5.57	38.582
	4	0.31	3.5	1.2	16	4.9	5.3	39.822
	5	0.44	5.37	1.6	18.5	6.3	5.93	41.024
	6	0.39	1.31	2	19	7.5	5.58	41.923
	7	0.43	2.44	2.2	19.5	7.5	5.17	42.809
	8	0.53	2.51	2.4	20	8.5	5.23	42.867
	9	0.05	5.42	0.3	9.5	N.D	6.77	38.75
3	1	0.12	3.1	0.4	11	N.D	4.16	38.156
	2	0.19	3.35	0.5	12.5	N.D	4.66	39.231
	3	0.22	3.24	0.7	14	3.6	4.06	40.11
	4	0.29	3.6	1.3	14.5	4.5	4.65	41.156
	5	0.37	5.44	1.4	17	5.5	5.01	42.269
4	0	0.1	0.98	0.4	11	N.D	5.25	34.577
	1	0.12	0.76	0.5	12.5	N.D	5.38	36.15
	2	0.19	3.57	0.9	14	3.5	5.06	37.552
	3	0.25	2.96	0.8	15	4	5.36	38.246
	4	0.33	1.77	1.2	16	4.6	5.2	39.694
	5	0.36	5.1	1.7	18.5	6.6	5.68	41.06
	6	0.45	7.4	1.9	19	7.4	5.07	41.809
	7	0.47	7.85	2	19.5	7.9	5.4	42.406
	8	0.51	6.13	2.1	20	8	5.7	42.554

sample	Exting time (day)	AT (mmol/g)	AT (mmol/kg)	AT (100 kg feed)	TPC (%)	polymer	OTI (100%) hour
5	0	0.1	1.05	0.1	11	N.D.	3.25
	1	0.15	1.55	0.5	12.5	N.D.	3.25
	2	0.25	2.2	1.8	14	5.5	2.28
	3	0.45	2.61	2.4	15	5.5	3.3
	4	0.65	3.80	6	16	5.5	3.85
	5	0.5	4.12	7.1	16	5.5	3.23
	6	0.85	2.25	14	19	7.1	3.44
	7	1.34	5.51	18	20	5.5	3.89
	8	1.57	2.75	21	21	8	3.87
9	0	0.1	0.94	0.1	11.5	N.D.	3.22
	1	0.18	3.07	0.7	12.5	N.D.	4.32
	2	0.3	4.4	1.8	14	N.D.	3.8
	3	0.41	3.18	2.7	15	5.5	4.54
	4	0.59	5.58	5.7	18.5	3.8	4.28
	5	0.87	5.89	6.3	18.5	3.9	3.47
	6	0.84	0.95	10	19	6.3	4.4
	7	1.06	1.08	12	19.5	?	5.04
	8	1.27	1.28	17.8	21	7.5	3.88
	9	1.37	1.88	20.08	22.5		3.83

[0105] While the invention has been particularly shown and described with reference to specific embodiments, it should be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope of the invention as defined by the appended claims. The scope of the invention is thus indicated by the appended claims and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced.

CLAIMS

1. A method for optimizing a blending formulation of an edible oil sample, the method comprising:
 - 5 receiving a dataset of values representing at least one type of index obtained from a plurality of pure oils and/or oil blends; and
 - generating a prediction of the optimized blending formulation from the received dataset of values,
 - wherein the step of generating the prediction of the optimized blending formulation
 - 10 comprises using a predictive model configured to generate a plurality of blending formulations based on the received dataset of values, evaluate at least one index value of each of the plurality of blending formulations and compare the evaluated at least one index value with at least one predefined threshold value to determine the optimized blending formulation from the generated plurality of blending formulations, the at least
 - 15 one predefined threshold value and the at least one index value being of the same type of index, and the at least one predefined threshold value being industrially approved.
2. The method of claim 1, wherein the predictive model is a genetic model constructed from at least one vector of features, wherein each feature corresponds to an
- 20 initial index value obtained from a specific pure oil or oil blend of the plurality of pure oils and/or oil blends, or an index value of the at least one index value.
3. The method of claim 2, wherein the initial index value comprises at least one of a frying life of the specific pure oil or oil blend, a fatty acid content of the specific pure oil
- 25 or oil blend, a price of the specific pure oil or oil blend, and a total polar compound value generated by the specific pure oil or oil blend during cooking.
4. The method of claim 2 or 3, wherein the genetic model comprises an input portion configured to receive the dataset of values, a genetic algorithm configured to determine a
- 30 fittest blending formulation based on an objective function, and an output portion comprising multiple outputs configured to present the fittest blending formulation as the optimized blending formulation.

5. The method of claim 4, wherein the genetic algorithm is further configured to evaluate a parameter of the optimized blending formulation, the evaluated parameter being representative of a predicted post-blend behavior over a specific time frame, and the multiple outputs are further configured to substantially simultaneously present the parameter at the output portion.
6. The method of any one of claims 1 to 4, further comprising generating a prediction of a parameter of the optimized blending formulation of the edible oil sample, the predicted parameter being representative of a predicted post-blend behavior over a specific time frame.
7. The method of any one of claims 1 to 6, wherein the type of index comprises an oxidation index, a nutritional index or a market index.
8. The method of claim 7, wherein the oxidation index comprises a total polar compound value, or a frying life, or an anisidine value, or a carbonyl value, or a thiobarbituric acid level, or a conjugated dienes acid value, or a conjugated trienes acid value, or a combinational value of conjugated dienes acid and conjugated trienes acid, or a polyunsaturated fatty acids content decrease, a polymer by-product value.
9. The method of claim 7, wherein the nutritional index comprises a fatty acid content, or a structured lipid level.
10. The method of claim 7, wherein the market index comprises a price.
11. The method of any one of claims 1 to 10, wherein the optimized blending formulation satisfies at least one of the following requirements:-
- (i) lowest price;
 - (ii) constraint imposed by the at least one predefined threshold value; and
 - (iii) longest frying life.

12. The method of any one of claims 1 to 11, further comprising generating the dataset of values, wherein the step of generating the dataset of values comprises:

performing a linear combination of first index values obtained from a plurality of pure oils and/or oil blends to form a landscape comprising second index values of the plurality of pure oils and/or oil blends, wherein the first index values and the second index values are of the at least one type of index;

applying a sampling algorithm to the landscape to sample from the second index values; and

forming at least part of the dataset of values based on the sampled second index values.

13. The method of claim 12, wherein the sampling algorithm is based on a Dirichlet distribution.

14. The method of any one of claims 1 to 13, wherein the step(s) of generating the prediction(s) are in real-time.

15. The method of any one of claims 1 to 14, wherein the step of receiving the dataset of values representing at least one type of index obtained from the plurality of pure oils and/or oil blends comprises receiving the dataset of values representing more than one type of index obtained from the plurality of pure oils and/or oil blends, wherein the more than one type of index comprises an oxidation value and a nutritional index, or an oxidation value and a nutritional index and a market index.

16. An edible oil sample predicted using a method of any one of claims 1 to 15.

17. The edible oil sample of claim 16, comprising a blended oil or a blended frying oil or a blended flavoured oil.

18. A computer readable storage medium comprising computer readable instructions operable when executed by a computer to optimize a blending formulation of an edible oil sample, the computer readable instructions configured to perform a method of any one of claims 1 to 15.

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19. An apparatus or system comprising:

a receiving unit configured to receive a dataset of values representing at least one type of index obtained from a plurality of pure oils and/or oil blends;

a memory for storing a prediction model, wherein the predictive model is
10 configured to generate a plurality of blending formulations based on the received dataset of values, evaluate at least one index value of each of the plurality of blending formulations and compare the evaluated at least one index value with at least one predefined threshold value to determine the optimized blending formulation from the
15 generated plurality of blending formulations, the at least one predefined threshold value and the at least one index value being of the same type of index, and the at least one predefined threshold value being industrially approved; and

a processor configured to access the prediction model stored in the memory to perform steps of a method of any one of claims 1 to 15 for generating a prediction of an optimized blending formulation of an edible oil sample.

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20. The apparatus or system of claim 19, further comprising a pre-processor unit configured to perform a linear combination of first index values obtained from a plurality of pure oils and/or oil blends to form a landscape comprising second index values of the plurality of pure oils and/or oil blends, wherein the first index values and the second
25 index values are of the at least one type of index, and to apply a sampling algorithm to the landscape to sample from the second index values to form at least part of the dataset of values based on the sampled second index values.