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Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

— *of inventorship (Rule 4.17(iv))*

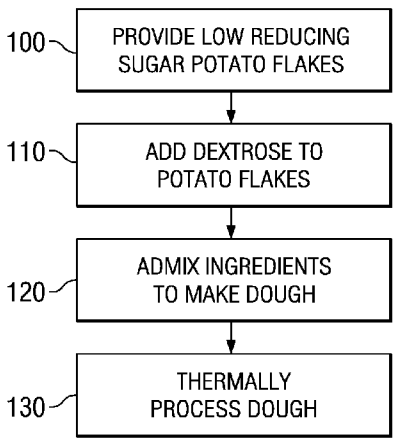
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(54) Title: METHOD FOR MAKING A LOW-ACRYLAMIDE CONTENT SNACK WITH DESIRED ORGANOLEPTICAL PROPERTIES

FIG. 1



(57) Abstract: A method for making a food product with a low acrylamide content having organoleptical properties comparable to traditional food products. Potatoes containing a low reducing sugar concentration are used to make potato flakes. Dextrose is added to the low reducing sugar potato flakes to increase the total reducing sugar concentration.

METHOD FOR MAKING A LOW-ACRYLAMIDE CONTENT SNACK WITH DESIRED ORGANOLEPTICAL PROPERTIES

BACKGROUND OF THE INVENTION

[0001] Technical Field

[0002] The present invention relates to a method of producing a snack having a low level of acrylamide.

[0003] Description of Related Art

[0004] The chemical acrylamide has long been used in its polymer form in industrial applications for water treatment, enhanced oil recovery, papermaking, flocculants, thickeners, ore processing and permanent-press fabrics. Acrylamide precipitates as a white crystalline solid, is odorless, and is highly soluble in water (2155 g/L at 30° C). Synonyms for acrylamide include 2-propenamide, ethylene carboxamide, acrylic acid amide, vinyl amide, and propenoic acid amide. Acrylamide has a molecular mass of 71.08, a melting point of 84.5°C, and a boiling point of 125°C at 25 mmHg.

[0005] In recent times, a wide variety of foods have tested positive for the presence of acrylamide monomer. Acrylamide has especially been found primarily in carbohydrate food products that have been heated or processed at high temperatures. Examples of foods that have tested positive for acrylamide include coffee, cereals, cookies, potato chips, crackers, french-fried potatoes, breads and rolls, and fried breaded meats. In general, relatively low contents of acrylamide have been found in heated protein-rich foods, while relatively high contents of acrylamide have been found in carbohydrate-rich foods, compared to non-detectable levels in unheated and boiled foods.

[0006] It is presently believed that acrylamide is formed from the presence of amino acids and reducing sugars. For example, it is believed that a reaction between free asparagine, an amino acid commonly found in raw vegetables, and free reducing sugars accounts for the majority of acrylamide found in fried food products. Asparagine accounts

for approximately 40% of the total free amino acids found in raw potatoes, approximately 18% of the total free amino acids found in high protein rye, and approximately 14% of the total free amino acids found in wheat.

[0007] Acrylamide has not been determined to be detrimental to humans, but its presence in food products, especially at elevated levels, is undesirable. As noted previously, relatively higher concentrations of acrylamide are found in food products that have been heated or thermally processed. Prior art methods of reducing the level of acrylamide adversely affect the quality and flavor of the finished product. Therefore, it would be desirable to develop a method of reducing the level of acrylamide in the end product of heated or thermally processed foods with minimal flavor impact.

SUMMARY OF THE INVENTION

[0008] The present invention is a method for making a thermally processed food product with a low acrylamide content having organoleptical properties comparable to traditional food products. According to one embodiment, dextrose is added to potato flakes with a low reducing sugar concentration to make a dough. The dough is then cooked according to prior art methods to make a low moisture, ready to eat product with an acrylamide content lower than products made with prior art potato flakes.

[0009] The above, as well as additional features and advantages of the invention will become apparent in the following written detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The novel features believed characteristic of the invention are set forth in the appended claims. The invention itself, however, as well as a preferred mode of use, further objectives and advantages thereof, will be best understood by reference to the following detailed description of illustrative embodiments when read in conjunction with the accompanying drawings, wherein:

[0011] Figure 1 depicts a general flow chart of a method for making a low-acrylamide snack piece with desired organoleptical properties in accordance with one embodiment of the present invention;

[0012] Figure 2 depicts a chart comparing the acrylamide reaction rates of fructose and dextrose.

DETAILED DESCRIPTION OF THE INVENTION

[0013] One embodiment of the present invention is directed towards a method for making a thermally processed food product with a reduced acrylamide content having organoleptical properties comparable to traditional food products. As used herein, a thermally processed food product is defined as a food product that has been thermally processed at a food product temperature of greater than about 120°C to moisture content of less than about 5% by weight, more preferably less than about 3% by weight, and most preferably less than about 2% by weight. Because reducing sugars drive both flavor and acrylamide, it can be difficult to lower the level of acrylamide while retaining desired organoleptical properties. The present invention achieves that balance by adding dextrose to potato flakes with a low reducing sugar concentration. As used herein, dextrose means the D-form of glucose and the terms are used interchangeably.

[0014] Referring to Figure 1, the first step of one embodiment of the present invention is to provide potato flakes with a reducing sugar concentration of less than about 0.5% by weight 100. These potato flakes can be made from potatoes with a low reducing sugar concentration, such as chipping variety potatoes or potatoes harvested when the weather is relatively warm. Chipping variety potatoes are those potatoes normally used for frying, such as Saturna, Lady Rosetta, Lady Clair, Hermes, Maris Piper, Erntestolz, Agria, Atlantic, Monona, Norchip, Snowden, Kennebec, Oneida, and Tobique. Of course, such potatoes are provided for purposes of illustration and not limitation. Any potato that can be made into potato flakes having a reducing sugar concentration of less than about 0.5% by weight can be used including, but not limited to proprietary and genetically engineered potatoes. As used herein, "low reducing sugar potato flakes" are potato flakes that comprise a native total reducing sugar concentration of less than about 0.5% by weight. In one embodiment, low reducing sugar flakes comprise a native reducing sugar concentration of

less than about 0.5% by weight. In one embodiment, potato flakes are treated with enzymes, fermentation, blanching, or other suitable method to achieve a total reducing sugar concentration of less than about 0.5% by weight. In one embodiment, potato flakes can be made from potatoes having relatively higher reducing sugar concentrations than chipping variety potatoes, including potatoes known to have a tendency to accumulate reducing sugars during low temperature storage such as Russet Burbank potatoes. Potato varieties can also be blended during the flake manufacturing process in accordance with the present invention. Potato flakes can be made from such low reducing sugar potatoes by methods known in the art as exemplified by methods disclosed in U.S. Patent No. 6,197,358.

[0015] In one embodiment, dextrose is added to the low reducing sugar potato flakes **110** so that the enhanced total reducing sugar concentration is less than or about equal the total concentration of native reducing sugars in prior art potato flakes. Consequently, in one embodiment, dextrose is added to the low reducing sugar flakes to provide an enhanced total reducing sugar concentration of less than about 1.2% and more preferably less than or equal to about 0.7% by weight of the potato flakes. These "enhanced" potato flakes contain less than about 0.5% native reducing sugars and less than about 1.0% and preferably less than about 0.7% of dextrose by weight. Dextrose advantageously provides the necessary flavor drivers in the finished product.

[0016] As used herein, reducing sugars means all carbohydrate molecules containing a free aldehyde or keto group, and/or hemiacetal group, for example fructose, glucose, maltose, galactose, lactose and pentose sugars such as xylose, and other aldehyde containing compounds. Although reducing sugars are broadly defined, in one embodiment the reducing sugars comprise fructose and glucose because fructose and glucose are the predominant reducing sugars natively present in the potato raw material.

[0017] Referring back to Figure 1, a dough is made by adding water and other minor ingredients as is well known in the art. The dough can then be thermally processed **130** for example by baking or frying, to make a final product with an acrylamide content lower than products made with prior art potato flakes having the same total reducing sugar concentration as the enhanced total reducing sugar concentration. In one embodiment, the dough is sheeted, cut, and thermally processed at a food temperature of at least about 120°C to a moisture content of less than about 3%.

[0018] At higher temperatures, the acrylamide formation rate for fructose is faster than that of dextrose. For example, Table 1 below depicts known second order rate constants of glucose and fructose with asparagine.

	120°C (248°F)	140°C (284°F)	160°C (320°F)	180°C (356°F)	200°C (392°F)
Fructose	0.0819	0.369	1.45	5.04	15.8
Glucose/Dextrose	0.131	0.308	0.668	1.35	2.58

Table 1. Second order rate constants (x 10^{-3}/min) for glucose and fructose reacting with asparagine.

[0019] A chart, based on the data provided in Table 1, depicting the comparative second order rate constants of fructose and dextrose is shown in Figure 2. Curve 201 represents the second order rate constant of fructose as a function of temperature and curve 202 represents the second order rate constant of dextrose as a function of temperature. The rate constants are similar up to about 300°F. At about 320°F the rate constant of fructose is slightly higher than that of dextrose, at about 350°F the rate constant of fructose is approximately four times that of dextrose, and at about 390°F, the rate of fructose is approximately six times higher than the rate constant of dextrose.

[0020] Through adding dextrose to low reducing sugar flakes it was discovered that the native reducing sugars, including fructose, dextrose and others, found in potatoes have a faster acrylamide formation rate than dextrose alone. Thus, the flavor of a product produced

from flakes having a low reducing sugar concentration can be enhanced by the addition of dextrose without suffering the acrylamide level from a product with the same total amount of reducing sugars where only native reducing sugars are present. Of the native reducing sugars present in potatoes, glucose and fructose predominate and are generally present in near equal amounts. Other reducing sugars, such as maltose, are generally present in very small amounts, comprising less than about 5% of the native reducing sugars. By increasing the ratio of dextrose to fructose in the potato flakes to increase the total reducing sugar concentration, the difference in the reaction rates of dextrose and fructose and dextrose and native reducing sugars can be exploited to yield a product with enhanced flavor and lower acrylamide content. In one embodiment, the amount of dextrose added to the low reducing sugar potato flakes increases the molar ratio of dextrose to fructose to at least about 2:1 and in one embodiment at least about 3:1.

[0021] In one embodiment, an effective amount of dextrose is added to the low reducing sugar potato flakes. As used herein, an "effective amount" means an amount of dextrose that achieves at least about 25% less acrylamide than products made with prior art flakes having only native reducing sugars at the same total reducing sugar concentration as the enhanced total reducing sugar concentration. In one embodiment, the amount of dextrose added constitutes at least half of the enhanced total reducing sugar concentration in the dough.

[0022] Example

[0023] Comparative tests were run between a control sample of prior art potato flakes and low reducing sugar flakes (purchased from Washington Potato, in Warden, Washington) having a native total reducing sugar concentration of 0.2% by weight. Various levels of dextrose were added to the flakes and the total concentration of reducing sugars was recorded. The fabricated chips were fried and tested for acrylamide and moisture content. The results are shown in the Table 2 below.

Sample	Acrylamide, ppb	Moisture,%	Total Reducing Sugar,%
Control	343	1.99	1.3
Potato flakes + 0.4% dextrose	216	1.83	0.6
Potato flakes + 1.0% dextrose	294	1.86	1.2
Potato flakes + 2.0% dextrose	516	1.67	2.2

Table 2. Comparative tests of prior art flakes and low reducing sugar flakes with dextrose added

[0024] As can be seen, the selective use of dextrose as the primary reducing sugar in potato flakes reduces acrylamide with minimal flavor impact. Adding 0.4% dextrose to low reducing sugar flakes to obtain a total reducing sugar concentration of 0.6% provides a chip having 37% less acrylamide than the control even when fried to a lower moisture content than the control. The addition of 1.0% dextrose to reach a total reducing sugar concentration of that substantially similar to the native reducing sugar level of prior art potato flakes achieves 14% lower acrylamide content at a lower moisture content. In one embodiment, dextrose is added in an amount to obtain a total reducing sugar concentration of about 1.2% or less, which achieves a lower acrylamide level while providing fried potato chips having a flavor profile on parity with fried potato chips made from prior art flakes.

[0025] Dextrose advantageously provides many of the same benefits as the native reducing sugars without the higher kinetic acrylamide reaction rates. For example, the flavor

drivers provided by native reducing sugars are due to Maillard reaction compounds, Strecker aldehydes, and pyrazines. When the inventive dough was tested for these flavor drivers, the levels of flavor drivers were comparable to fried potato chips made from prior art potato flakes. Interestingly, Maillard reaction compounds in the finished product made with the inventive dough increased with increasing levels of dextrose. Strecker aldehydes were similar to control at 1% dextrose and higher than control at 2% dextrose. Pyrazines in the finished product were similar to control at 2% dextrose.

[0026] Though the present invention has been described with reference to potato flakes, it is to be understood that the invention is also applicable to potato granules and corn masa as corn generally contains near equal amounts of fructose and glucose. The examples and explanations given are not meant to limit the present invention.

[0027] Having thus described several aspects of at least one embodiment of this invention, it is to be appreciated that various alterations, modifications, and improvements will readily occur to those skilled in the art. Such alterations, modifications, and improvements are intended to be part of this disclosure, and are intended to be within the spirit and scope of the invention. Accordingly, the foregoing description and drawings are by way of example only.

CLAIMS:

We claim:

1. A method for making a dough, said method comprising the steps of:

   a) providing potato flakes having a reducing sugar concentration of less than about 0.5% by weight, and

   b) adding an effective amount of dextrose to said potato flakes to make a dough.

2. The method of claim 1 wherein said effective amount of dextrose raises the total reducing sugar concentration of said potato flakes to less than about 0.7%.

3. The method of claim 1 wherein said potato flakes are made from potatoes with a low reducing sugar concentration.

4. The method of claim 1 wherein said potato flakes are made from potatoes or potato flakes treated with enzymes.

5. The method of claim 1 wherein said potato flakes are made from potatoes or potato flakes treated with yeast.

6. The method of claim 1 wherein said potato flakes are made from potatoes or potato flakes treated by fermentation.

7. The method of claim 1 wherein said potato flakes are made from potatoes or potato flakes treated by blanching.

8. The method of claim 1 further comprising the step of cooking said dough at 120°C to a moisture content of less than about 3%.

9. The method of claim 1 wherein said dextrose added at step b) comprises at least 50% of an enhanced total reducing sugar content.

10. The method of claim 1 wherein the ratio of dextrose to fructose in said dough is at least 2:1.

11. Potato flakes for making a thermally processed food product, said potato flakes comprising less than about 0.5% native reducing sugars and less than about 1.0% of dextrose by weight of said flakes.

12. The potato flakes of claim 11, wherein a total reducing sugar concentration of said potato flakes is less than about 0.7% by weight of said flakes.

13. The potato flakes of claim 11 wherein said potato flakes are made from potatoes with a low reducing sugar concentration.

14. The potato flakes of claim 11 wherein said potato flakes are made from potatoes or potato flakes treated with enzymes.

15. The potato flakes of claim 11 wherein said potato flakes are made from potatoes or potato flakes treated with yeast.

16. The potato flakes of claim 11 wherein said potato flakes are made from potatoes or potato flakes treated by fermentation.

17. The potato flakes of claim 11 wherein said potato flakes are made from potatoes or potato flakes treated by blanching.

18. The potato flakes of claim 11 wherein said dextrose comprises at least 50% of an enhanced total reducing sugar content.

19. The potato flakes of claim 11 wherein the ratio of dextrose to fructose in said dough is at least about 2:1.

20. The potato flakes of claim 11 wherein the ratio of dextrose to fructose in said dough is at least about 3:1.

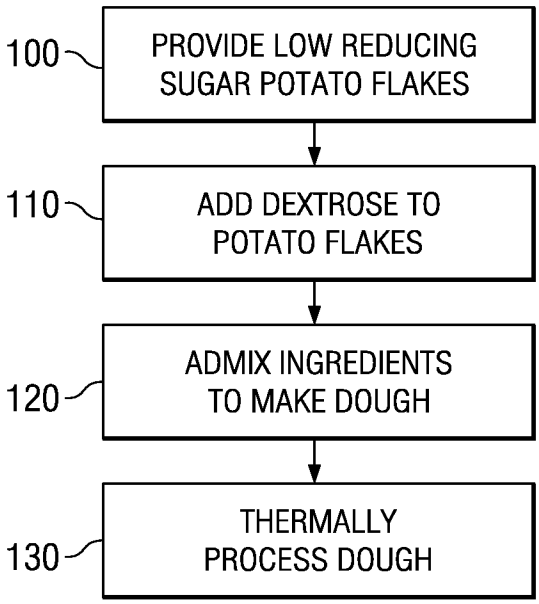

100
PROVIDE LOW REDUCING SUGAR POTATO FLAKES
110
ADD DEXTROSE TO POTATO FLAKES
120
ADMIX INGREDIENTS TO MAKE DOUGH
130
THERMALLY PROCESS DOUGH

FIG. 1

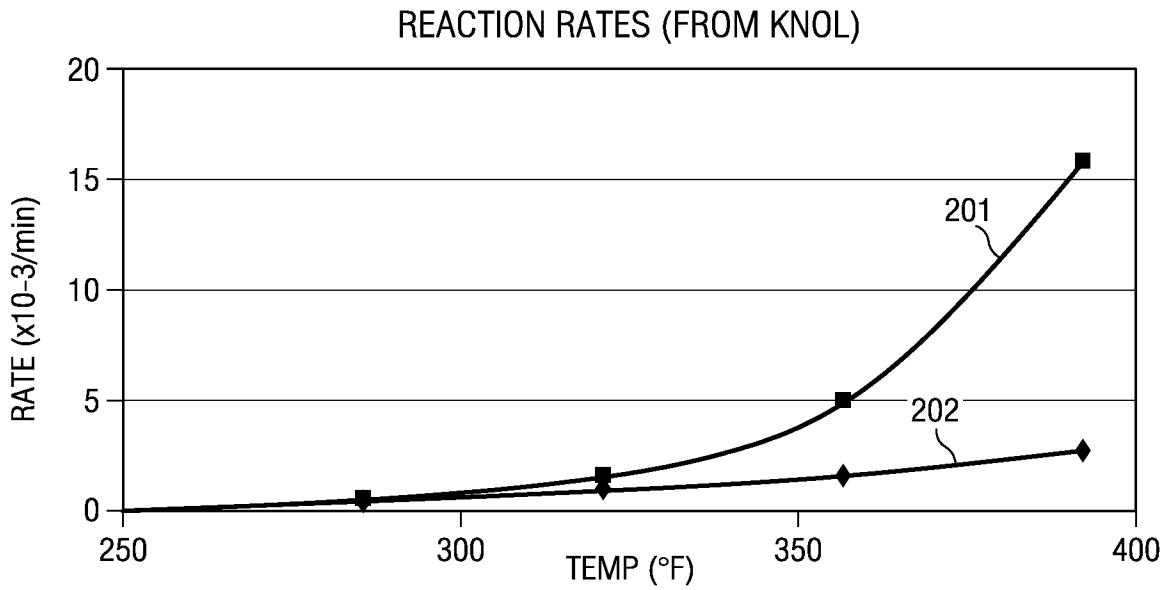

REACTION RATES (FROM KNOL)
RATE (x10-3/min)
20
15
10
5
0
250
300
350
400
TEMP (°F)
201
202

FIG. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 09/66104

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - A23L 1/2165; A23P 1/06 (2010.01)
USPC - 426/637, 426/96
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
426/637, 426/96

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Electronic Databases Searched: PubWEST DB=PGPB,USPT,USOC,EPAB,JPAB; PLUR=NO; OP=ADJ, Google Scholar, Google Patent
Search Terms Used: potato$, acrylamide,low, reduced, minimiz$, decreas$, dextrose, reducing sugar, enzym$, yeast, ferment$, blanch$

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 20070178219 A1 (Boudreaux et al.) 2 August 2007 (02.08.2007) entire document, esp: abstract, paras: [0007], [0008], [0012], [0020], [0055], [0061], [0092], [0099], Tables 16A, 16B, 16C; Fig. 1, Fig. 6.	1-4, 11-14 5-10, 15-20
Y	US 20050214411 A1 (Lindsay et al.) 29 September 2005 (29.09.2005) entire document, esp: abstract, paras: para [0013], [0027], [0033], Example 1.	5, 15
Y	US 20070141226 A1 (Elder et al.) 21 June 2007 (21.06.2007) entire document, esp: abstract. para [0012].	6, 16
Y	US 20080299273 A1 (Bhaskar et al.) 4 December 2008 (04.12.2008) entire document, esp: abstract, paras: [0014], [0026], [0028], [0051], [0052], Fig. 3.	7, 8, 17
Y	US 20070166439 A1 (Soe et al.) 19 July 2007 (19.07.2007) entire document, esp: abstract, paras: [0063], [0190].	9, 10, 18-20

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14 January 2010 (14.01.2010)	02 FEB 2010
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774