What was the optimum formulation of a healthful bread with less added NaCl and more dietary fiber using surface response methodology?

Watson Dana Z*, Hernández Maria, Colombo Maria Elena, Lema Silvia N and Vázquez Marisa B*

Universidad de Buenos Aires, Escuela de Nutrición, Facultad de Medicina, Argentina

Abstract

There is an association between high NaCl intake and high blood pressure. The World Health Organization recommends salt intakes up to 5 g/day (NaCl) and a total fiber intake of 25 g/day. In Argentina it is estimated that 190 g of bread per capita are consumed per day, with an average salt content of 2%, providing approximately 4 g of NaCl to the daily intake. The objective was optimizing the formulation of a bread using the response surface methodology (RSM) in blind acceptability and with nutritional information. A Box-Behnken design was applied to the formulation prototypes for 3 critical factors: added NaCl (levels: <65%, <50% y <35%), dietary fiber (levels: >15%, >50% y>75%) y yeast (levels: <50%, conventional y>50%), taking as reference the white bread. The 15 prototypes were evaluated by 45 consumers in blind acceptability and with nutritional information. The same consumers participated in both stages. A 10-point scale was used (1-dislike extremely and 10-like extremely). The determination of the optimal bread/s was obtained via RSM. The sample of consumers consisted of 53.3% men with a median age of 28 years. The interaction stage*added NaCl was significant as the highest average acceptability values were for prototypes with <35% NaCl added for any of the stages. The added NaCl*dietary fiber interaction was also significant as the highest average values of acceptability were for prototypes with <35% added NaCl for any of the dietary fiber levels. By using the RSM it was possible to predict the optimal level of added NaCl, dietary fiber and yeast, for an acceptability of 7 points, for the blind stage and with nutritional information. The optimal formulation of a healthy bread obtained was <35% of added NaCl>75% of dietary fiber and >50% yeast in relation to white bread.

Introduction

The World Health Organization (WHO) recommends the intake of salt amounting up to 5 g per day (NaCl) and a total fiber intake of 25 g/day, from different sources, such as vegetables, fruits, grains and whole grains [1,2].

There is an association between high NaCl intake and high blood pressure (HBP), which is the most important risk factor in the development of cardiovascular diseases and strokes [1,3]. It has been observed that modest reductions of NaCl in the diet contribute substantially to reduce cardiovascular events in the population [4]. In Argentina and around the world, actions are being taken to reduce the intake of NaCl [5].

There formulation of processed products is one of the most cost-effective strategies to achieve a decrease in NaCl intake. In Argentina it is estimated that 190 g of bread per capita is consumed per day, with an average salt content of 2%, providing approximately 4 g of NaCl to the daily intake [6-8].

Diets with high dietary fiber content have proved to have positive effects on satiety, intestinal peristalsis, reduction of cholesterol values and improving glycemic control [9]. According to the Argentina’s National Survey of Nutrition and Health (ENNyS), the median daily fiber intake is 9.39 g, 97.2% of women between 10 and 49 years old have inadequate fiber intake [10].

During the development or reformulation of a product, both analytical and affective sensory tests are needed to evaluate acceptability [11]. Response surface methodology (RSM) is one of the methods used to optimize products and processes, since it allows reducing the number of tests that are carried out and choose the best alternative within a series of possible options [11,12].

It is important to keep in mind that nutritional information accompanying a product plays a fundamental role in the consumer’s response, influencing expectations and perceptions referred to the product, as well as its acceptability [13].

Based on what has been mentioned above, the development of bakery products with low NaCl content and high fiber content is a strategy in order to offer consumers food choices aimed at healthy eating.

The objective of the present work was to optimize the formulation of a bakery product (bread) using the RSM in 2 stages (blind acceptability and with nutritional information).

Materials and methods

The work protocol was approved by the Comité de Ética Humana, Secretaría de Ciencia y Técnica, Facultad de Medicina, Universidad de...
Buenos Aires. Consumers were invited to participate in the study and the dynamics of the test were explained to them. The participation was voluntary, and the informed consent process was previously carried out.

According to the recommendations for a healthy diet it is necessary to reduce the consumption of NaCl and increase fiber consumption. When including these recommendations in the formulation of healthy bread, it was necessary to consider the effect of the yeast facing these modifications in the final texture of the product. So, the critical factors were:

- Added salt (added NaCl)
- Dietary fiber
- Fresh yeast

A Box-Behnken design was applied to the formulation prototypes because it has a lower number of experimental units compared to the 3n designs, as it is formed with the combination of 2n designs and incomplete block designs. The critical factors were given determined three levels each, taking as a reference the white bread (Table 1).

Table 1. Experimental design of the samples

| Prototype | Added NaCl | Dietary Fiber | Yeast |
|-----------|------------|---------------|-------|
| A         | <35%       | >15%          | Conventional |
| B         | <35%       | >50%          | <50%  |
| C         | <35%       | >50%          | >50%  |
| D         | <35%       | >75%          | Conventional |
| E         | <50%       | >15%          | <50%  |
| F         | <50%       | >15%          | >50%  |
| G         | <50%       | >50%          | Conventional |
| H         | <50%       | >50%          | Conventional |
| I         | <50%       | >50%          | Conventional |
| J         | <50%       | >75%          | <50%  |
| K         | <50%       | >75%          | >50%  |
| L         | <65%       | >15%          | Conventional |
| M         | <65%       | >50%          | <50%  |
| N         | <65%       | >50%          | >50%  |
| O         | <65%       | >75%          | Conventional |

The prototypes were evaluated in 2 stages: blind acceptability and acceptability with nutritional information. Consumers were the same in both stages. The time of the interval between the first and the second stage was 1 week [22]. In each stage, the 15 prototypes were evaluated in 2 sessions: session 1=evaluation of 8 prototypes and session 2=evaluation of 7 prototypes (interval between sessions of 30 minutes).

- STAGE 1: Blind acceptability: the samples were presented monadically in balanced order, following a Latin Squares design. Each

Sensory analysis of blind acceptability and with nutritional information

The 15 prototypes were evaluated by a panel of 45 habitual consumers of bread [21].

The prototypes were evaluated in 2 stages: blind acceptability and acceptability with nutritional information. Consumers were the same in both stages. The time of the interval between the first and the second stage was 1 week [22]. In each stage, the 15 prototypes were evaluated in 2 sessions: session 1=evaluation of 8 prototypes and session 2=evaluation of 7 prototypes (interval between sessions of 30 minutes).

- STAGE 1: Blind acceptability: the samples were presented monadically in balanced order, following a Latin Squares design. Each
sample of 1 slice of bread of 10±1 gram, was served in transparent disposable tray (7×7×4 cm) and coded with a 3-digit number. Consumers tested the samples, waiting 1 minute between each one and wiping their mouths with water. The global acceptability was evaluated using a 10-point scale (1=dislike extremely and 10=like extremely) in a self-administered form.

- STAGE 2: Acceptability with nutritional information: The nutritional information included: the name of the product (BREAD), the percentages of decrease in NaCl added, the percentages of increase in dietary fiber and the ingredients of each prototype. The dynamics of the test and the scale used was equal to STAGE 1, only consumers were asked to read the nutritional information before testing the samples. At the end, the participants completed the socio-demographic questionnaire (self-administered) that included the following variables:

  - Age: measured in years
  - Gender: categorized Female/Male
  - Work: categorized in Yes/No
  - Study: categorized in Yes/No
  - Type of bread consumed: categorized in White bread/Whole-wheat bread/Both
  - Moment of the day in which it consumes bread: categorized in Breakfast/Lunch/Tea time/Dinner/Between meals/Others
  - Type of bread you usually buy: categorized in Craft based bread/Industrial bread/Both

**Statistical analysis**

The sample was described according to the characterization variables. The numerical variable (age) was expressed as median and interquartile range. The dichotomous and categorical variables were expressed in absolute values and percentages.

Analysis of the Variance (ANOVA) was performed on acceptability scores of the 15 prototypes. Averages were compared using Fisher’s LSD method. A value of 5% was considered significant for the comparison of averages.

The Genstat software was used (Version 19, VSN International, Hemel Hempstead, United Kingdom).

The determination of the optimal bread/s was obtained via RSM with the MINITAB software (Version 15, Minitab Inc.). A significance level of 5% was considered in the analysis.

**Results**

The 15 prototypes of the bakery were elaborated successfully by the baker cook, according to a standardized recipe.

The sample of consumers consisted of 53.3% of men, with a median age of 28 years. 57.8% and 71.1% indicated that they study and work respectively. When asked about the type of bread they consumed 40% of the evaluators reported only white bread, while 33.3% indicated consuming white and whole-wheat breads. As for the bread they bought 51.2% referred to buying only industrial bread and 24.4% bought both: industrial and craft-based bread. Breakfast and tea time were the moments most chosen by consumers to eat bread (33) (Table 5).

**Table 5. Characterization of the 45 consumers**

| Characteristics | Consumers n (%) |
|-----------------|-----------------|
| Age (years) - Median (IR*) | 28 (11) |
| Gender | |
| Female | 21 (46.7%) |
| Male | 24 (53.3%) |
| Study | |
| Yes | 26 (57.8%) |
| No | 19 (42.2%) |
| Work | |
| Yes | 32 (71.1%) |
| No | 13 (28.9%) |
| Type of bread consumed | |
| White bread | 18 (40.0%) |
| Whole bread | 12 (26.7%) |
| Both | 15 (33.3%) |
| Type of bread you usually buy | |
| Craft based bread | 11 (24.4%) |
| Industrial bread | 23 (51.2%) |
| Both | 11 (24.4%) |
| Day time | |
| Breakfast | 32 (32.3%) |
| Lunch | 10 (10.1%) |
| Tea | 33 (33.3%) |
| Dinner | 11 (11.1%) |
| Between meals | 11 (11.1%) |
| Others | 2 (2.1%) |

TR: Interquartile range

Of the total prototypes evaluated, the one that obtained the highest average score of acceptability by consumers was prototype C, in both blind stage (7.02, DS: 1.79) and with nutritional information (6.98; DS: 1.50). The following prototypes were also found with average scores of acceptability above 6.5: A, J, K and D.

The prototypes with 65% reduction of added NaCl presented acceptability values of 6 or less points, both blindly and with nutritional information (except the prototype O in blind stage).

Subsequently, factorial ANOVA of the acceptability of the 15 prototypes was performed.

The interaction stage∗added NaCl was significant for a p value=0.012. It is important to remember that, when using the Box-Behnken design to obtain the prototypes, 3 replicas of the design center are included, resulting in 3 prototypes equal with the central levels for each factor and another 12 different prototypes, making a total of 15 prototypes. Due to this, different repetitions are observed in the NaCl factor levels added for each stage. The highest average acceptability values were for the prototypes with <35% NaCl added for any of the two stages (Table 6).

The added NaCl∗Dietary fiber interaction was also significant (p=0.048). As mentioned above, the number of repetitions varies, depending on the levels of added NaCl and dietary fiber that interact, due to the Box-Behnken design used. The highest average values of acceptability were for the prototypes with <35% added NaCl for any of the dietary fiber levels and no difference in acceptability was observed. The lowest average values were for bread prototypes with <65% of added NaCl. But when the reduction of NaCl was <50% and the amount of added fiber of 75% the acceptability was significantly higher than for the bread with 15% added fiber (Table 7).

No statistically significant differences were found for the interactions Stage∗Dietary fiber (p=0.594), Stage∗Yeast (p=0.439), added NaCl∗Yeast (p=0.334) and Dietary fiber∗Yeast (p=0.939).
Determination of the optimum bread/s

For the implementation of the graphics by the RSM it was necessary to work with an ordinal numerical scale, so the levels of each factor were expressed in grams, since the "Conventional Yeast" level was not a numerical value.

The response surface graphs explain the effect of the independent variables (added NaCl, Dietary fiber and Yeast) on the dependent (Acceptability).

The results of blind acceptability and with nutritional information stages are presented in Figure 1.

When acceptability was carried out blindly, the following was observed:

A) Acceptability graph in function of added NaCl factor and dietary fiber factor: it can be seen that the acceptability of the bread is increasing as the amount of added NaCl and dietary fiber increases.

B) Acceptability graph in function of added NaCl factor and Yeast factor: it is observed that the higher the content of added NaCl and Yeast, the greater the acceptability of the product.

C) Acceptability graph as a function of the Dietary fiber factor and the Yeast factor: the acceptability of the Dietary fiber goes down to > 50% and then rises to reach the maximum acceptability value with the highest level of Dietary fiber. Regarding the amount of Yeast, the highest values of acceptability are observed when the concentrations are at extreme levels.

In the stage with nutritional information, the results were:

D) Acceptability graph in function of added NaCl factor and Dietary fiber factor: the acceptability of the bread is increasing as the amount of added NaCl increases. The same happens with the content of Dietary fiber.

E) Acceptability graph in function of added NaCl factor and Yeast factor: it is seen that the higher the content of added NaCl and of Yeast, the greater the acceptability of the product.

F) Acceptability graph according to the Dietary fiber factor and Yeast factor: acceptability goes down to > 50% and, then, rises until reaching the maximum acceptability value with the highest level of Dietary fiber. Regarding the amount of Yeast, the highest values of acceptability are observed when the concentrations are at extreme levels.

Table 6. Acceptance averages for the Stage×NaCl added interaction

| Stages                        | NaCl added | LSD* | LSD** |
|-------------------------------|------------|------|-------|
|                               | <65%       |      |       |
| Acceptability (repetitions)   | 6.01 (180) | 6.27 (315) | 6.69 (180) |
| Acceptability (repetitions)   | 5.48 (180) | 6.15 (315) | 6.82 (180) |

*Least Significant Difference (p<0.05) to compare means with the same number of repetitions
**Least Significant Difference (p<0.05) to compare means with different number of repetitions

Table 7. Acceptance averages for the NaCl added×dietary fiber interaction

| NaCl added | Dietary Fiber | LSD* | LSD** |
|------------|---------------|------|-------|
|            | >15%          |      |       |
|            | >50%          |      |       |
|            | >75%          |      |       |
| Acceptability (repetitions) | 5.72 (90) | 5.65 (180) | 5.92 (90) |
| Acceptability (repetitions) | 5.97 (180) | 6.16 (270) | 6.57 (180) |
| Acceptability (repetitions) | 6.90 (90) | 6.72 (180) | 6.66 (90) |

*Least Significant Difference (p<0.05) to compare means with the same number of repetitions
**Least Significant Difference (p<0.05) to compare means with different number of repetitions

Figure 1. Response surface graphs of acceptability: Blind and with nutritional information
By using the MSR it was possible to predict the optimal level of added NaCl, Dietary fiber and Yeast, for an acceptability of 7 points, both for the blind stage and with nutritional information. In this way, an optimal prototype was obtained for each stage (Table 8).

Taking into account the nutritional goals for a healthy diet and recommendations for the daily intake of dietary fiber [2] and that both prototypes have the same levels of added NaCl and Yeast, but not of Dietary fiber, it was decided to define as the optimal prototype the bread with: <35% of added NaCl; >75% of dietary fiber; >50% yeast than white bread.

Discussion

The use of the Box-Behnken design allowed us to formulate and elaborate a smaller number of experimental units to optimize the healthful bread, as 15 prototypes were made, instead of 27. Other researchers have used it for the optimization of the ingredients in the development of products with good results. Some works include foods such as noodles with different combinations of wheat flour, soybean and cassava starch [23]; wheat and soy crackers with added turmeric [24]; and yogurt [25].

The 15 prototypes of the bread were elaborated successfully. In Ireland, Lynch EJ et al. [26] studied the impact of NaCl reduction on the characteristics of dough and bread, finding that it can be reduced from 1.2% to 0.3-0.6% without meaningfully affecting them.

According to Carrillo E et al. [13], the nutritional information that accompanies a product plays a fundamental role in the consumer’s response, as it can influence their expectations and their perceptions of it, as well as its acceptability. NaCl reduction content in food products usually generates a negative impact on the expectation and/or the acceptability of these [22,27]. In contrast, in the incorporation of fiber or substitution of sugar by other sweeteners can have a positive impact [28,29].

When performing the acceptability test in the blind stage and, 1 week later, with nutritional information, differences were found for NaCl levels. When the reduction was <65% in the stage with nutritional information, consumers gave a lower score. For the reduction levels of <35% and <50% NaCl there were no differences. When the reduction of NaCl was <50% and the amount of added fiber of 75% the acceptability was significantly higher than for the bread with 15% added fiber. This could be due to the interaction of the ingredients in relation to the flavor in the bread favoring the acceptability [30,31].

Some strategies directed at reducing the sodium content in foods, without affecting their acceptability, consist of progressive reductions in the amount of NaCl. Girgis S et al. [32] achieved an acceptability rate of 25% with the reduction of the salt content in white bread in 6 weeks. In contrast, Antúnez et al. [33] studied the partial replacement of NaCl with KCl (30% reduction of the NaCl content in bread with a KCl replacement). Other authors achieved good levels of acceptability on the part of consumers with decreases in the amount of NaCl added between 20 and 30% [6,34].

The RSM was used to achieve the optimization of the bread and to predict the optimal levels for each factor, for an acceptability of 7 points. The effectiveness of RSM in the development and optimization of cereal-based products was also highlighted by other research groups [24,35,36].

As a result of the optimization, two optimal formulations of bread were obtained where the difference was in the fiber content: when the prototypes were evaluated blindly, the optimal level was >15% fiber, but when they received the nutritional information, the optimal level of fiber increase was >75%. One might think that consumers have knowledge about the health benefits of fiber intake and this influenced acceptability [37]. A study carried out by Krolak et al. [38] indicated that those consumers who have knowledge about nutrition attach more importance to fiber intake, to the nutritional information of the products and also more frequently consume whole or fiber enriched breads. So, optimal healthy bread contains 35% less added NaCl, 50% more yeast and 75% more fiber than white bread. The nutritional quality of the bread was evaluated through the application of the Nutrient Profile Model proposed by the Pan American Health Organization (PAHO) [39] and it was observed that it presented the critical nutrients (free sugars, fats saturated, trans fats, total fats, sodium and other sweeteners) aligned to the limits proposed by profiling.

Conclusion

The optimal formulation of healthy bread obtained was <35% of added NaCl>75% of dietary fiber and >50% yeast in relation to white bread.

A product with these characteristics would be a very good strategy to offer different food options to the consumer that aim at a healthy diet. That is why the next step of research will be the measurement of its acceptability in a large number of consumers.

Acknowledgments

Marcelo Kullish for the making of bread prototypes.
Dr. Guillermo Hough for the critical look of the results.
Tony Watson for the revision of the English translation to the paper.

Funding information

Subsidio UBAcYT 20020130200089BA (Universidad de Buenos Aires, Argentina).

Competing interest

The authors have not financial or non-financial, professional, or personal competing interests for consideration during the review process.

References

1. Organización Mundial de la Salud (2018) Reducir la ingesta de sodio para reducir la tensión arterial y el riesgo de enfermedades cardiovasculares en adultos. https://www.who.int/elenal/titles/sodium_cvd_adults/es/ [accessed 05-11-18].
2. Ministerio de Salud de la Nación (2016) Guías Alimentarias para la Población Argentina, Documento Técnico Metodológico. http://www.msal.gob.ar/images/stories/bes/graficos/0000000817/cen-2016-04_Guia_Alimentaria_completa_web.pdf [accessed 05-11-18].
3. Antman EM, Appel LJ, Baletline D, Johnson RK, Steffen LM, et al. (2014) Stakeholder discussion to reduce population-wide sodium intake and decrease sodium in the food supply: a conference report from the American heart association sodium conference 2013 planning group. Circulation 129: e660-e679. [Crossref]
Watson Dana Z (2018) What was the optimum formulation of a healthful bread with less added NaCl and more dietary fiber using surface response methodology?

4. Bibbins-Domingo K, Chertow GM, Coxson PG, Moran A, Lightwood JM, et al. (2010) Projected effect of dietary salt reductions on future cardiovascular disease. N Engl J Med 362: 590-599. [Crossref]

5. Lema SN, Watson DJ, Vázquez MB (2013) Sal y salud: avances en conocimientos, acciones y propuestas. Actualización en nutrición 14: 176-181.

6. Ferrante D, Apro N, Ferreira V, Virgolini M, Aguilar V, et al. (2011) Feasibility of salt reduction in processed foods in Argentina. Rev Panam Salud Publica 29: 69-75. [Crossref]

7. Lezcano EP (2011) Análisis de producto: productos panificados. Ministerio de agricultura de la nación, Alimentos Argentinos. pp: 1-27.

8. Valverde Guillén M, Picardo Pérez J (2013) Estrategias mundiales en la reducción de sal/sodio en el pan. Rev CostarrCostarPublica 22: 61-67.

9. American Diabetes Association (2013) Standards of medical care in diabetes 2013 - position statement. Diabetes Care 36: S11-S86. [Crossref]

10. ENNyS (2007) Encuesta nacional de nutrición y salud, Programa materno infantil en salud, Ministerio de Salud de la nación, república Argentina. http://www.msal.gob.ar/imases/estudios/2007/encuesta_nacional_de_nutricion_y_salud.pdf [accessed 05-11-18].

11. Stone H, Bleibaum RN, Thomas HA (2012) Sensory evaluation practices. 4th edition. Academic Press, Estados Unidos.

12. Jiménez M, Margalef MI (2008) Diseño Sensorial para el Desarrollo de Alimentos. Cmi Ediciones, Salta, Argentina.

13. Carrillo E, Varela P, Fiszman S (2012) Packaging information as a modular of consumers’ perception of enriched and reduced-calorie biscuits in tasting and non-tasting tests. Food Qual Prefer 25: 105-115.

14. Kuehl RO (2001) Diseño de Experimentos. Principios estadísticos de diseño y análisis de investigación. 2da Edición. Thomson Learning, México.

15. AOAC 934.01 (2000) Official methods of analysis of AOAC international, 17th Ed., Gaithersburg, MD.

16. AOAC 942.05 (2000) Official methods of analysis of AOAC international, 17th Ed., Gaithersburg, MD.

17. AOAC 991.20 (2000) Official methods of analysis of AOAC international, 17th Ed., Gaithersburg, MD.

18. AOAC 954.02 (2000) Official methods of analysis of AOAC international, 17th Ed., Gaithersburg, MD.

19. AOAC 985.29 (2000) Official methods of analysis of AOAC international, 17th Ed., Gaithersburg, MD.

20. AOAC 968.08 (2000) Official methods of analysis of AOAC international, 17th Ed., Gaithersburg, MD.

21. Deshpande RP, Chiman MS, McWatters KH (2008) Optimization of a chocolate-flavored, peanut-soy beverage using response surface methodology (RSM) as applied to consumer acceptability data. LWT – Food Science and Technology 41: 1485-1492.

22. Vázquez MB, Curia A, Hough G (2009) Sensory descriptive analysis, sensory acceptability and expectation studies on biscuits with reduced added salt and increased fiber. J Sens Stud 24: 498-511.

23. Vijayakumar TP, Joopathy P (2012) Optimization of ingredients for noodle preparation using response surface methodology. J Food Sci Technol 51: 1501-1508. [Crossref]

24. Adegoke GO, Oyekunle AO, Afolahi MO (2017) Functional biscuits from wheat, soya bean and turmeric (Curcuma longa): Optimization of ingredients levels using response surface methodology. Res J Food Nutr 1: 13-22.

25. Chen L, Alkazar J, Yang T, Lu Z, Lu Y (2018) Optimized cultural conditions of functional yogurt for γ-aminobutyric acid augmentation using response surface methodology. J Dairy Sci 101: 10685-10693. [Crossref]

26. Lynch EJ, Dal Bello F, Sheehan EM, Cashman KD, Arendt EK (2009) Fundamental studies on the reduction of salt on dough and bread characteristics. Food Res Int 42: 885-891.

27. Bolhuis DP, Newman LP, Keast RS (2016) Effects of Salt and Fat Combinations on Taste Preference and Perception. Chem Senses 41: 189-195. [Crossref]

28. Hoppert K, Zahn S, Jänecke L, Mai R, Hoffmann S, et al. (2013) Consumer acceptance of regular and reduced-sugar yogurt enriched with different types of dietary fiber. Int Dairy J 18: 1-7.

29. Reis F, Alcâtre F, Delíza R, Ares G (2017) The role of information on consumer sensory, hedonic and wellbeing perception of sugar-reduced products: Case study with orange/pomegranate juice. Food Qual Prefer 62: 227-236.

30. Adams SO, Maller O, Cardello AV (1995) Consumer acceptance of foods lower in sodium. J Am Diet Assoc 95: 447-453. [Crossref]

31. Kilcast D, Angus F (2007) Reducing salt in foods. Practical strategies. Woodhead publishing series in food science, technology and nutrition, UK.

32. Girgis S, Neal B, Prescott J, Prendergast J, Dumbrell S, et al. (2003) A one-quarter reduction in the salt content of bread can be made without detection. Eur J Clin Nutr 57: 616-620. [Crossref]

33. Antilmez L, Giménez A, Vidal L, Ares G (2018) Partial replacement of NaCl with KCl in bread: Effect on sensory characteristics and consumer perception. J Sens Stud 33: e12441.

34. La Croix KW, Fiala SC, Colonna AE, Durham CA, Morrissey MT, et al. (2014) Consumer detection and acceptability of reduced-sodium bread. Public Health Nutr 18: 1412-1418. [Crossref]

35. Kumar KA, Sharma GK, Khan MA, Semwal AD (2015) Optimization of multigrain premix/for high protein and dietary fibre biscuits using response surface methodology (RSM). Food and Nutrition Sciences 6: 747-756.

36. Shahsavani-Mojarrad L, Rafie A (2018) Effect of high-amylose corn starch addition on canning of yellow alkaline noodle composed of wheat flour and microbialtransglutaminase: Optimization by RSM. Food Sci Food Nutr 6: 1204-1213. [Crossref]

37. Baixauli R, Salvador A, Hough G, Fiszman SM (2008) How information about fibre (traditional and resistant starch) influences consumer acceptance of muffins. Food Qual Prefer 19: 628-635.

38. Królak M, Jezewska-Zychowicz M, Sajdakowska M, Gebski J (2017) Does perception of dietary fiber mediate the impact of nutrition knowledge on eating fiber-rich bread? Nutrients 9: 1255. [Crossref]

39. Organización Panamericana de la Salud (2016) Modelo de perfil de nutrientes de la Organización Panamericana de la Salud. http://iris.paho.org/xmlui/handle/123456789/18622 [accessed 05-11-18].