Effect of Xanthan Gum Inclusion on the Physical, Proximate and Sensory Properties of Wheat-soya Milk Bread

Adamu, H., Ocheme, O.B., Makeri, M.U., Shehu A.B., Tasiu, Y.G & Adamu, Z.

Abstract

The aim of the study was to determine the effect of different levels of xanthan gum inclusion on the physical, chemical and sensory properties of wheat-soymilk bread. Xanthan gum was added from 0% (control) up to 4% into the bread and baked using the straight dough method. The bread was assessed for physical, chemical and sensory acceptability using standard methods. Data was analyzed using statistical package for social sciences (SPSS) version 16.0. Xanthan gum significantly ($p<0.05$) decreased loaf volume from 400.0 cm^3 to 250.0 cm^3 and specific volume from 2.6 g/cm^3 to 1.5 g/cm^3 but significantly ($p<0.05$) increased loaf height from 1.8 cm to 3.2 cm, loaf weight from 1.8 cm-3.2 cm and oven spring from 0.2 cm-1.2 cm. Proximate composition of bread loaves showed a significant difference ($p<0.05$) with all level of xanthan gum from 0% (control) to 4%. Xanthan gum had no significant effect on sensory properties although the control bread was the most acceptable with a score of 7.6 for general acceptability. The study recommends that the volume of dough and soymilk be increased with the same level of Xanthan gum of 1-4% as used in this work.

Keywords: Sensory properties, xanthan gum, bread, soya milk.

Introduction

Bread is a baked food product that has been eaten since ancient period (Karimi *et al.*, 2012). It is a vital source of easily consumed and digested carbohydrate (Lambert *et al.*, 2009) that varies from country to country (Victoria and Felix, 2009). The basic ingredients for bread include wheat flour, water, yeast and salt (Martin, 2004; Sluimer, 2005). Today a wide range of ingredients namely milk, egg, polysaccharide, soya milk, spice and seeds may be added to enrich bread, bring about varieties, improve texture and taste (Oluwajoba *et al.*, 2012). Soymilk is an aqueous, white, creamy extract produced from soybeans which is similar to cow milk in appearance and consistency (Deepika *et al.*, 2017) It is one of the nutrients that can be used to fortify bread since it is a rich and economic source of protein, fat, carbohydrates vitamins and minerals which are abundantly available (Adebayo *et al.*, 2008). It is used in many bakery products to improve their nutritional and sensory properties (Padmavathi and Prabhavathy, 2012). However in view of the fact that gluten is the major structure forming protein present in wheat bread and is responsible for the viscoelastic properties, water-binding capacity and structure of bread by entrapping gasses to form an open spongy cell crumb of gluten (Sabanis and Tzia, 2011; Gallagher, 2009), it is a challenge to produce high quality bread using soymilk. Sanni, (2012) stated that the use of soya milk in place of water to produce bread causes a reduction in physical attributes such as loaf volume, loaf weight and oven spring. Therefore, to obtain the afore-mention properties of bread, different types of hydrocolloids (natural, synthetic and biotechnological) in bread formulation have been studied (Anton and Artfield, 2008). Xanthan gum, guar gum, carboxy methylcellulose and hydroxypropyl methylcellulose (Mariotti *et al.*, 2013) and so on are required for production of quality bread after adding nutritional improved mixtures to wheat due to their ability to control the rheology and texture of aqueous systems within starch (Gallagher *et al.*, 2004).

Xanthan gum, a natural polysaccharide that belongs to a family of substance known as hydrocolloids is produced by the bacterium *Xanthomonas campestries* used widely in food industries as a thickener due to its ability to produce highly viscous and stable aqueous solution (Heinze *et al.*, 2006). They are added to bakery products to prevent staling during storage by retaining moisture, improving cohesion of starch granules, assisting with the structure and retention of CO_2 as well as increasing volume (Michelle *et al.*, 2006). Finally, nutritional improved mixtures of wheat and other ingredients can take advantage from hydrocolloids addition in order to compensate a diminished quality. From this, it is thought that the nutrients released in the soymilk will play an important role in baked product. The objective of the study was to produce wheat-soya milk bread and to assess the effect of different levels of xanthan gum on the physical, proximate and sensory quality of the bread so as to ascertain its acceptability. The above results if favorable will help to increase the protein intake of bread consumers.

Materials and Methods

Xanthan gum was bought from Mekang Resources and Allied Distribution Ltd Company, Lagos. Vitasoy Soya Milk was bought from Bomas Super Market, Minna, Nigeria. Wheat flour and other ingredients were purchased at Minna central Market, Nigeria. This research work was carried out in the Department of Food Science and Nutrition, Federal University of Technology Minna, Niger State Nigeria.

Table 1: Recipe for bread making

Ingredients	Percentage (%)
Flour	100.00
Yeast (Saccharomyces *cerevisiae*)	1.00
Salt	1.50
Sugar	4.00
Fat	2.50
Water	23.25
Soya milk	23.25
Xanthan gum	0-4% of flour weight

Source: Chin *et al.* (2010)

Sample Preparation

Sample formulations were baked using the straight dough method with the formulation given in Table 1). In one mixing, 1kg of wheat flour was used to produce two muffin size loaves. The bread making process involved seven main steps: mixing, dividing, intermediate proofing, molding, proofing, baking and cooling. The flour and all ingredients were mixed for 15 minutes in a Kenwood food mixer (Model A 907 D) until a fully developed dough was formed. Mixed dough was removed from the mixer to a working table and immediately divided into two pieces, covered with damp clean muslin cloth for intermediate proofing for 10 min at room temperature (29° C). The dough was then hand kneaded, moulded into a greased loaf pan and further proofed in a proofing cabinet for 150 min at 30 °C. After proofing, the dough was baked at 230°C for 30 min, cooled and packaged before further analyses were carried out.

Determination of Physical Properties of Bread

Loaf volume was measured by rapeseed displacement method (AACC, 2000). A container was used to measure the volume using small grain (Pearled millet). Pearled millet was poured into the container of known volume until the bottom was covered. The loaf was placed inside the container which was then filled to the top with more seeds. The extra pearled millet, which equals the loaf volume, was measured in a graduated cylinder. Specific volume was determined by dividing the loaf volume by its corresponding loaf weight using the following equation:

$$SV\ (cm^3/g) = \frac{\text{loaf volume of bread}}{\text{Weight of bread}}$$

Loaf weight, loaf height and oven spring were determined according to the method described by Mepba *et al.* (2007). The loaf weight was determined by using a calibrated weighing balance after 1 hour of removal from the oven, the weight expressed in gram (g). Loaf height was measured using a graduated scale 1 hour after removal from the oven and expressed in centimeter (cm) and while oven spring was determined from the difference in height of dough before and after baking.

Determination of Proximate Composition of Bread

The proximate composition of samples was determined according to AOAC (2000). Moisture content of the samples was oven dried at 105°C to constant weights. Ash content was determined by using the muffle furnace at 550° C. Crude protein was determined using micro kjeldah method. Crude fat was determined by Soxhlet extraction method. Crude fibre was determined by digesting the sample in a reagent mixture (Trichloroacetic acid, acetic acid, nitric acid and distilled water) boiled, reflux, dry and ash. Carbohydrate was obtained by difference.

Determination of Sensory Attributes of Bread

The sensory attributes including colour, taste, aroma and overall acceptability were evaluated by untrained 20-member panel of staff and students from the Department of Food Science and Technology Federal University of Technology, Minna, Niger State, Nigeria, using a 9-point Hedonic scale according to Stone and Sidel (2004) where 1 represented the least score (extremely dislike) and 9 the highest score (extremely like). Analysis of Variance (ANOVA) was performed on the data gathered by means of SPSS statistical software (16.0 version).

Result

The results of the Physical properties are presented in Table 2. At 1, 2 and 4% xanthan gum inclusion, the decrease in bread volume was not significant ($p>0.05$). However, at 3% level of inclusion, the volume decreased significantly ($p<0.05$) from 400 cm^3 (control) to 250 cm^3. The same trend was observed for specific volume. The weight and height of the bread sample increased significantly ($p<0.05$) with increasing level of xanthan gum inclusion. The weight of the control sample was 150 g. this increased to 154, 157, and 160 g at 2%, 3% and 4% level of xanthan gum inclusion respectively, while the height of the control sample which was 1.8 cm increased significantly ($p<0.05$) to 2.4, 2.9, and 3.2 cm at 1%, 3% and 4% level of inclusion respectively. Inclusion of 4% xanthan gum significantly increased the oven spring threefold from 0.4 cm to 1.2 cm.

Table 2: Effect of xanthan gum inclusion on the physical characteristics of wheat-soya milk bread

Parameters	Control	1% XG	2%XG	3%XG	4%XG
Volume (cm3)	400.0±14.14^{a}	330.0±28.28^{ab}	335.0±0.00^{ab}	250.0±70.71^{a}	320.0±28.28^{ab}
Specific vol (g/cm3)	2.6±0.09^{a}	2.1±0.11^{ab}	2.1±0.01^{ab}	1.5±0.45^{b}	1.6±0.61^{a}
Weight (g)	150±0.00^{d}	150±0.70^{d}	154±0.70^{c}	157±0.00^{b}	160±0.00^{a}
Height (cm)	1.8±0.42^{d}	2.4±0.00^{c}	2.0±0.00^{d}	2.9±0.00^{b}	3.2±0.07^{a}
Oven spring	0.4±0.28^{b}	0.2±0.14^{b}	0.2±0.07^{b}	0.5±0.00^{d}	1.2±0.07^{a}

Values are Mean ± SD (n=3). Values in the same row with different superscripts are significantly different (Pd• 0.05). *XG: Xanthan gum

The result of the proximate Composition of the bread sample is presented in Table 3. Xanthan gum inclusion (at 1% level significantly ($p<0.05$) increased the moisture content from 24.4 to 35.5%) significantly ($p>0.05$) decreased the protein content from 16.8% to 16%. Xanthan gum inclusion at 2, 3 and 4% significantly ($p<0.05$) increased the fat content of the bread from 2.7% to 4.5, 4 and 4.2% respectively. Inclusion of xanthan gum at 1 and 2% significantly ($p>0.05$) decreased the crude fibre of the bread from 1.6% to 1.2 and 1.3% respectively. Inclusion of xanthan gum at 3 and 4% levels significantly ($p<0.05$) increased the ash content from 1.7% to 2 and 2.2% respectively while the carbohydrate content was significantly lower in the bread with 1% xanthan gum.

Table 3: Effect of xanthan gum inclusion on the proximate composition of wheat-soya milk bread

Parameters (%)	control	1% XG	2%XG	3%XG	4%XG
Moisture content	24.4±3.19^{a}	33.5±2.16^{a}	28.6±0.77^{ab}	26.4±2.12^{a}	24.6±2.36^{a}
Ash content	1.7±0.07^{b}	1.7±0.06^{b}	1.6±0.01^{b}	2.0±0.08^{a}	2.2±0.08^{a}
Crude protein	16.8±0.09^{ab}	16.0±0.37^{c}	17.5±0.46^{a}	16.7±0.14^{b}	17.0±0.16^{ab}
Fat content	2.7±0.35^{b}	3.7±0.35^{ab}	4.5±0.70^{a}	4.0±0.00^{a}	4.2±0.36^{a}
Crude fibre	1.6±0.05^{a}	1.2±0.00^{b}	1.3±0.06^{b}	1.6±0.01^{b}	1.6±0.10^{a}
Carbohydrate	52.6±2.90^{a}	43.7±2.12^{b}	46.2±2.02^{ab}	49.1±2.03^{ab}	50.2±2.70^{a}

*Values are Mean ± SD (n=3). Values in the same row with different superscripts are significantly different (Pd" 0.05).**XG: Xanthan gum

The result of the sensory evaluation is presented in Table 4. Xanthan gum inclusion decreased bread colour significantly ($p<0.05$) at 1, 2 and 4% levels of inclusion. However, at 3% level of inclusion, the colour decreased significantly ($p<0.05$) from 8.1 (control) to 6.6. Xanthan gum inclusion showed no significant difference for aroma, taste and overall acceptability.

Table 4: Effect of xanthan gum inclusion on the Sensory Properties of wheat-soya milk bread

Parameters	Control	1% XG	2%XG	3%XG	4%XG
Colour	8.1 ± 0.85^{a}	7.6 ± 0.99^{ab}	7.0 ± 1.45^{bc}	6.6 ± 1.38^{c}	7.3 ± 1.52^{abc}
Aroma	7.0±0.97	6.8±0.87	6.7±1.20	6.4±1.05	6.3±1.41
Taste	7.4±1.05	7.5±1.05	7.2±1.29	7.0±1.37	7.3±1.49
Overall acceptability	7.6±0.74	7.5±0.94	7.3±0.97	6.8±1.34	7.0±1.83

Values are Mean ± SD (n=20). Values in the same row with different superscripts are significantly different (Pd" 0.05). *XG: Xanthan gum

Discussion

Effect of Xanthan Gum inclusion on the Physical Characteristics of Wheat-Soya Milk Bread

The inability of the bread samples to increase in volume despite the inclusion of xanthan gum may be due to dis-improvement of dough development and less gas retention which decreases dough viscosity and dough stability (Rosell, 2011). This result is in agreement with Lazaridou *et al.* (2007) who reported that addition of 1% xanthan gum did not improve specific volume and that volume even decreased when xanthan gum was added at 2%. In baked products, hydrocolloids (such as xanthan gum) influence the dough rheology and bread quality parameters (Maria *et al.*, 2013). Bread volume and specific volume depends on the level of xanthan gum added and the level of water incorporation. Loaf volume reduction during baking is an undesirable economic quality to the bakers as consumers often get attracted to bread loaf with higher volume believing that it has more substance for the same price.

The ability of the bread samples to increase in weight, height and oven spring may be due to the quantity and concentration of dough baked and the amount of moisture and carbon-dioxide (Co_2) diffused out of the loaf during baking (Anton and Artfield, 2008). Increments in height, weight and oven spring are desired qualities in bread which from the result can be obtained by the use of xanthan gum.

Effect of Xanthan Gum Inclusion on the Proximate Composition of Wheat-Soya Milk Bread

The observed increase in moisture content may be due to moisture retention ability of hydrocolloids (xanthan gum), chemical structure and the interaction with the remaining ingredients of the food (Rosell *et al.*, 2011). This result is in conformity with the report of Shittu *et al.* (2009) who reported that a maximum of 1% xanthan gum was required to stop bread from drying. The decrease observed in protein content may be attributed to the high amount of moisture present. Increase in lipid, crude fibre and total ash contents could be attributed to increased organic material with increased level of xanthan gum. Decrease in protein is not a desired quality since the aim of using soya milk is to increase the nutritional content of the bread have been defeated.

Effect of Xanthan Gum Inclusion on the Sensory Properties of Wheat-Soya Milk Bread

The level of significance observed in the sensory properties of the bread samples may be due to reduction of available water in the dough, resulting in a lower rate of browning. This result is in agreement with the work of Maria *et al.* (2013) who reported that decrease in colour on addition of xanthan gum is attributed to reduced maillard reaction which occurs between wheat protein and reducing sugar. The development of colour during baking is an important indication of bread quality (Esteller, 2008; Yi *et al.*, 2009). Therefore, a decrease in colour is not desired.

Conclusion

The physical analysis of the wheat-soymilk bread shows that Xanthan gum inclusion significantly increased loaf weight and loaf height. Inclusion of xanthan gum at 4% level significantly increased oven spring. However, xanthan gum inclusion at all levels did not improve or increase the loaf volume of wheat-soya milk bread rather it caused a decrease in the volume of the bread. Xanthan gum inclusion at 1% level significantly increased the moisture content but significantly reduced the protein content of wheat-soya milk bread. The sensory analysis also indicates that generally, the control bread without xanthan gum was accepted. The preference may be due to the non-inclusion of xanthan gum

Recommendations

1. Further studies should be undertaken to identify ways by which the physical properties of wheat-soya milk bread can be improved
2. Bread baking with larger volumes of dough and soymilk with the same level of 1-4% xanthan gum as use in the experiment should be made.
3. Other hydrocolloids should be use to improve wheat-soymilk bread

References

AACC. (2000). Approved Methods of the American Association of Cereal Chemists. 9th Edition. Eagan, Minn, USA.

AOAC. (2002). Official Method of Analytical Chemists. 1 6th edition. Washington, DC.

Adebayo, T.B.C., Adegoke, A.A. & Akinjogunla, O.J. (2008). Microbial and Physico-Chemical Quality of Powdered Soymilk Samples in Akwa Ibom, South Southern Nigeria. *African Journal of Biotechnology*, 8(13), 3066-3071.

Anton, A.A. & Artfield, S.D. (2008). Hydrocolloids in Gluten-Free Bread: A Review. *International Journal of Food Science and Nutrition*, 59(1),11-23.

Chin, NL., Rahman, R.A., Hashim, D.M. and Kowng, S.Y. (2010). Palm Oil Shortening Effects on Baking Performance of White Bread. *Journal of Food Processing Engineering*, 33, 413–433.

Deepika, K., Sanjay, K., Shuchi, U. and Ritesh, M. (2017). Preservation & Processing of Soymilk: A Review. *International Journal of Food Science and Nutrition*, 6 (2), 66-70.

Esteller, M.S & Lannes, S.C.S. (2008). Production and Characterization of Sponge Dough Bread using Scaled Rye. *Journal of texture studies*, 39 (1), 56-57.

Giami, S.Y., Amasisi T. and G. Ekiyor. (2004). Comparison of Bread Baking Properties of Composite Flour from

Kernels of Roasted and Boiled African Breadfruit (Treculia Africana) Seeds. *Journal of Raw Material Research*, 1, 16-25.

Gallagher, E. (Editon) (2009). *Gluten-Free Food Science and technology* (Vol.55). London, England:Wiley-Blackwell.

Gallagher, E., Gormley, T.R., & Arendt, E.K. (2004). Recent Advances in the Formulation of Gluten- Free Cereal-Based Products. *Trend in Food Science andTechnology*, 15(3), 143-152.

Heinze,T., Liebert, T., Heublein, B. & Flornig, S. (2006). Functional polymers based on dextran. *Advance Polymer Science*, 205, 199-291.

Karimi, M., Fathi, M., Sheykholeslam, Z., Sahraiyan, B. & Naghipoor F. (2012) Effect of Different Processing Parameters on Quality Factors and Image Texture Features of Bread. *Journal of Bioprocessing and Biotechniques*, 2, 127

Lambert, J. L., LE-BAIL, A., Zuniga, R., VAN-HAESENDONCK, I., Vnzeveren, E., Petit, C. & COLIC-BARIC I. (2009). The Attitude of European Consumers Towards Innovation in Bread; Interest of the Consumers Towards Selected Quality Attributes. *Journal of sensory studies*, 24(2), 204-219.

Martins, p. (2004). Controlling the Bread Making Process: The Role of Bubbles in Bread. *Cereal Foods World*, 49(2), 72-75.

Maria, E., Ulf, S., Jorge, O. and Lilia A. (2013). Effect of Cassava Flour Characteristics on Properties of Cassava-Wheat-Maize Composite Bread Types. *International Journal of Food Science and Technology DOI:10,1155/2013/305407*

Mariotti, M., Ambrogina, P.M., & Lucisano, M. (2013). The Role of Buckwheat and HPMC on the Breadmaking Properties of some Commercial Gluten-Free Bread Mixtures. *Food Hydrocolloids*, 30, 393-400.

Mepba, H.D., Eboh, L & Nwaojigwa, S. (2007). Chemical Composition, Functional and Baking Properties of Wheat –Plantain Composite Flour. *African Journal of food Agriculture, Nutrition and Development* 7(1), 1-22

Michelle, M., Moore, M.H., Peter, D. H. M., Ulmer, I. & Elke, K. (2006). Network Formation in Gluten-Free Bread with Application of Transglutaminase. *Cereal Chemistry*, 83(1), 28–36.

Oluwajoba, S. O., Malomo1, O., Ogunmoyela1, O. A. B., Dudu1, O. E. & Olumide, A. O. (2012). Microbiological and Nutritional Quality of Warankashi Enriched Bread. *Journal of Microbiology, Biotechnology and Food* Sciences, 2 (1), 42-68.

Padmavathi, D.I & Prabhavathy, D.N. (2012). Development of value added Bakery Products using Soya Milk. *Research Journal of Recent Sciences*, 1(12), 64-66.

Rosell, C.M., Rojas, J.A & Benedito de, B. C. (2011). Influence of Hydrocolloids on Dough Rheology and Bread Quality. *Journal* of *Food Hydrocolloids*, 15, 75-81.

Sabanis, D. & Tzia, C. (2011). Effect of Hydrocolloids on Selected Properties of Gluten-Free Dough and Bread. *Journal of Food Science and Technology International*, 17(4). 279-291

Sanni, A. (2012). Effect of replacement of water with soymilk on bread quality. Unpublished B.Sc thesis. Department of food science and Nutrition Federal University of Technology Minna Niger State.

Sluimer, P. (2005). Principles of Breadmaking: Functionality of Raw Materials and Process Steps. *American association of cereal chemists*, St. Paul.

Stone, H. & Sidel, J.L. (2004). Descriptive analysis. In Sensory evaluation practices. *London Academic press*, page, 202–226.

Victoria A. J & Felix C. O. (2009). Optimization of Wheat-Sprouted Soybean Flour Bread using Response Surface Methodology. *African Journal of Biotechnology*, 8(22), 6364-637.

Yi, J., Jounson & Kerr, W.L. (2009). Properties of Bread Made from Frozen Dough Containing Waxy Wheat Flour. *Journal of cereal science*, 50 (3), 364-369.