Ma. Edelwina M. Blase, International Journal of Advances in Agricultural Science and Technology,
Vol.4 Issue.10, October- 2017, pg. 105-111 ISSN: 2348-1358
Impact Factor: 6.057

Sensory Attributes and Proximate Analysis of Sinalab: A Traditional Gluten-free Flat Bread of Marinduque from Arrowroot (Maranta arundinacea Linn)

Ma. Edelwina M. Blase

Marinduque State College, Philippines
dhel4blase@yahoo.com

Abstract

Sinalab is a traditional flat bread made in the province of Marinduque using arrowroot (Maranta arundinacea Linn) starch. A sinalab premix was made from arrowroot starch gathered in the province and it was made into baked sinalab using equal amounts of water, coconut milk and evaporated milk. These products were subjected to sensory evaluation by 25 panelists using a 5-point hedonic scale for colour, flavour / aroma, texture / mouth feel, taste and general acceptability. Likewise, the premix sinalab was subjected to proximate analysis. Results of the study revealed that the most acceptable product was the premix sinalab with evaporated milk, especially in terms of taste. But it was not significantly different ($p<0.05$) from the product with coconut milk in terms of colour, flavour / aroma, mouth feel and general acceptability. The sinalab premix powder had low moisture content, crude fat, protein, ash and fiber, but high in nitrogen free extracts. Likewise, these proximate contents of the premix sinalab further increase with the addition of evaporated milk, especially in terms of moisture. The evaporated milk improved the baked sinalab in terms of taste and flavour / aroma, which made it acceptable to the panelists.

Keywords: arrowroot, flat bread, Maranta arundinacea Linn., Marinduque, sinalab

1. Introduction

Worldwide, about 737 million metric tons of wheat was produced in year 2015 - 2016 (Statistics Portal), thus a large variety of food products, like breads, including flat breads are made of wheat flour.

Flat breads, on the other hand, are considered as one of the oldest forms of bread (Kahlon & Chiu, 2012). They maybe leavened or unleavened (Gocmen, et al., 2009) and vary from country to country with more than 60 types worldwide, like the tortillas in Mexico, chappati in India, and shaobin in China (WMC, 2008). As such, they are consumed as staple food by many of the people worldwide (Kamaliroosta, et al., 2016).

Since wheat flour is associated with gluten, a mixture of protein, celiac disease becomes prevalent, wherein one out of 200 persons worldwide is suffering from this disease (Fasano & Catassi, 2001, Wangen, 2009). Gluten is not only found in wheat and its products, but also found in barley, rye, and cross breeds of these (Watson, et al., 2009; Bakshi, et al., 2012; FDA, 2013).

Though most people with celiac disease can tolerate less than 20 ppm of gluten in foods (Kahlon and Chiu, 2012, 2014), this amount is very small and therefore substitution or forming composite flours that are gluten-free is some of the attempts made to come up with a gluten-free foods. A gluten-free diet has been considered as the standard treatment for this disease (Welstead, 2015).

A number of gluten-free flat breads have been studied, such as the Mesoamerican staple food tortilla made from corn flour, the Ethiopian kitta from maize and sweet potato and the ancient whole grain gluten-free flatbreads were prepared with quinoa, teff, amaranth and buckwheat flours (Kahlon and Chiu, 2012).

Arrowroot flour based from studies is gluten-free (Shepherd and Gibson, 2006; Jyothi, et al., 2009; Sinnamon, 2011), like the flours of amaranth, buckwheat, cassava, chia, chickpea, corn, flax, millet, nuts, oat, potato, quinoa, rice, sorghum, soybean, spelt, sweet potato and teff (Watson, et al., 2009; Pourafshar, et al., 2010; Bakshi, et al., 2012).

As such, this study looked on the gluten-free flat bread of Marinduque, called sinalab, which is traditionally made from arrowroot starch.

Old folks of the province mentioned that the word sinalab was obtained from the Tagalog word alab, which means "a glowing fire" and the Marinduque word sinalaban, which means "put into fire by adding more firewood or dry materials" like in a bonfire.

While sinalab has its roots in Marinduque, an old age flat bread, there seems no record or studies or literatures regarding this traditional bread (Andam and Labay, 2010). Thus, this study looked on the sensory evaluation and the proximate composition of sinalab flat bread in Marinduque.

2. Body of the Article

Extraction of the Arrowroot Starch (AS).
Arrowroot rhizomes were harvested from the field trials in Gasan, Marinduque on May 24, 2016. They were cleaned, washed and rasped for 10-15 minutes using the fabricated Arrowroot Rasping Machine with a mean capacity of 46.2 kg/hr and starch recovery of 16.12% (Pascua, 2015). The duly rasped rhizomes were placed in a finely mesh abaca cloth and squeezed them by hand with enough water. The starch was collected in an aluminum basin and washed three times with potable water until the yellowish-brown supernatant liquid turned clear and the settled starch turned white. The starch was separated from the supernatant liquid, dried in solar drier at a mean temperature of 45oC for six hours then shifted into powdery substance to remove the bigger lumps.

Preparation of the premix sinalab.
A premix sinalab powder was made from the newly prepared arrowroot starch with a combination of 75% AS and 25% refined sugar (99% refined). They were mixed well in an aluminum bowl and shifted to fineness. Half a kilogram of the powdery mixture was placed in stand up aluminum pouch at room temperature and properly labelled.

Preparation of the sinalab flat bread.
Sinalab flat breads were made using the premix sinalab. Batter was prepared using 250 g premix, 30 mL coconut oil, one beaten egg and a cup of buko strips (young coconut meat strips). For treatment 1, 120 mL water was added. Water was replaced with pure coconut milk for treatment 2 and evaporated milk for treatment 3. The coconut milk was extracted from 250 grams grated coconut with 150 mL water and squeezed thoroughly using double layered cheesecloth. Three replicates for each treatment were done. Each treatment was blended in an electric blender for 5 minutes until became a homogenized batter. One-fourth cup of the homogenized batter from each treatment was baked into sinalab using preheated pan at 65oC and maintained at temperature of 120oC. The batter was baked for two minutes then flipped on the other side for another two minutes until light brown. An average of 10-15 sinalab could be made for each treatment.

Sensory evaluation.
The newly baked sinalab were evaluated by 25 panelists composed of food technology faculty members, students and bakers in terms of the products' appearance, aroma/flavour, texture (mouth feel), taste and general acceptability. The panelists were selected based on familiarity on the sinalab products. Three replicates for each treatment per sample were coded and presented randomly to the panelists. They were instructed to evaluate each sample at room temperature using prepared score cards for five-point hedonic scale ranging from

like extremely (5) to dislike extremely (1). Each panelist was served with a piece of the sinalab, one treatment at a time in random order. Bottled mineral water was provided to the evaluators for mouth rinse before another set of food product was given to them.

Proximate composition and nutritional facts.

The methods employed by the Association of Official Analytical Chemists (AOAC, 2006) were used in the determination for per cent moisture, ash, crude fat, crude protein, fiber and free nitrogen extracts of the arrowroot starch and premix sinalab, including the nutritional facts of the premix for labelling purposes. These were conducted in the Food Science Laboratory of the University of the Philippines—College of Agriculture at Los Baños, Laguna.

Statistical analysis.

All values for the sensory evaluation scores of the different products were presented as mean scores and subjected to analysis of variance. The mean scores for appearance, aroma, texture or mouth feel, taste and general acceptability were interpreted using the following ranges with the following adjectival ratings:

4.50 – 5.00	Like extremely
3.50 – 4.49	Like very much
2.50 – 3.49	Neither like nor dislike
1.50 – 2.49	Dislike very much
0.50 – 1.49	Dislike extremely

Significant differences between means were identified by Duncan's multiple range tests (significant for $p<0.05$). All values for the proximate composition of the arrowroot flour, sinalab premix and nutritional facts were reported as means of three replicates.

Results and Discussion

Sensory evaluation of sinalab samples.

The mean sensory evaluation scores of the sinalab flat breads are presented in table 1. They are ranging from 3.58 to 4.64, with sensory attributes rated as "like very much" to "like extremely".

Table 1. Sensory mean scores of *sinalab* using water, coconut milk and evaporated milk.

Treatment	Appearance	Aroma / flavour	Texture or mouthfeel	Taste	Overall acceptability
T_1 (AS : water)	3.80^{b}	3.58^{b}	4.20^{a}	3.64^{c}	3.76^{b}
T_2 (AS: coconut milk)	4.16^{ab}	4.00^{a}	4.32^{a}	4.24^{b}	4.12^{a}
T_3 (AS: evaporated milk)	4.48^{a}	4.33^{a}	4.48^{a}	4.64^{a}	4.28^{a}

Note:

1. N = 25 evaluators
2. AS (arrowroot starch)
3. Mean values are three replicates of the test samples and those with different superscript letters are significantly different ($p<0.05$)
4. Score range: 4.50 – 5.00 (like extremely), 3.50 – 4.49 (like very much), 2.50 – 3.49 (neither like nor dislike), 1.50 – 2.49 (dislike very much) and 0.50 – 1.49 (dislike extremely)

There is significant difference in the mean appearance of the sinalab, especially in terms colour ($p<0.05$). The products have slightly charred surface due to frying with off-white to light brown colour. The light brown colour of the product with evaporated milk was much preferred by the panelist, thus got a mean rating of 4.48. This appears almost the same as that of sinalab with coconut milk (4.16). The light brown appearance of the products was due to Maillard or browning reaction which is true among baked products with reducing sugar and amino acids (O'Brien and Morrissey, 1989; Martins et al., 2000). This may be due to low amino acid content of arrowroot starch as compared to other flours (Kumalasari et al., 2012; Aprianita et al., 2014). The off-white colour of treatment 1, was the least acceptable colour to the panelist, rated 3.80, which means different from sinalab with milk but similar with that with coconut milk (Table 1). This could be related to the findings of Eichner and Karel (1972) that an increase in the amount of water means a decrease in the browning

reaction between reducing sugars and amino acids. It could be attributed also to the low amount of reducing sugar and amino acids present in the mixture, unlike in treatments 2 and 3 with added coconut milk and evaporated milk as sources of additional amino acids and sugar.

There was also a significant difference in the flavour / aroma of the sinalab products ($p<0.05$). Treatments 2 and 3 with coconut milk and evaporated milk were not different from each other but diferent from treatment 1 with plain water added. According to Izzo and Ho (1992) and van Boekel (2006), the Maillard reaction does not only about browning of the baked products, but also about the formation of Maillard-based flavour or aroma due to generated sugar-protein interactions during baking. Though the distinctive nutty flavour of fried young coconut strips was observable in the three treatments, the product with evaporated milk gave also a distinctive milky to creamy-sugary aroma which the panelists liked most, thus given with a mean rating of 4.33 ($p<0.05$). This is same as that of treatment 2 with coconut milk with mean rating of 4.00. It was presumed that the protein present in the evaporated milk and coconut milk further enhance the flavour or aroma of the products. This could be further related to the Maillard sugar-peptide formed during the baking process as observed by Ogasawara, et al. (2006) in baked products. Treatment 1, with plain water was significantly different from treatments 2 and 3, with coconut milk and evaporated milk respectively. Its smoky to slightly sugary flavour was least acceptable to the panelists, thus a mean rating of 3.58 ($p>0.05$).

In terms of texture or mouth feel, no significant difference was observed by the panelists between the three sinalab products made ($p>0.05$). The soft, flaccid and chewy texture of baked arrowroot starch that could be easily congealed by heat had remained all throughout in the three treatments and their respective replicates.

In terms if taste, there was a significant difference among the sinalab products ($P<0.05$). Treatment 3, with evaporated milk was most favoured by the panelists with the highest mean rating of 4.64. This was so far the highest mean rating given by the panelists among the attributes measured and got an adjectival rating of "like extremely". It was presumed that the Maillard-based flavour between evaporated milk and sugar which was formed during baking further enhanced the taste of the product. This was followed by treatment 2, with coconut milk with a mean rating of 4.24, "like very much". These could be attributed also to the formed Maillard-based flavour between the proteins of coconut milk and added sugar, which was distinct from treatment 3. Treatment 1, with plain water got the lowest mean rating of 3.64. The panelists mentioned that this product had inferior taste as compared to treatments 2 and 3. This may be due to the less amount of protein present in the arrowroot batter that led to low amount of Maillard sugar-peptide flavour that could enhance the taste of the product.

In terms of general acceptability, treatment 3, with evaporated milk was most acceptable to the panelists with a mean rating of 4.28. This had been followed by treatment 2 with coconut milk with a mean rating of 4.12. Statistically, these two products were not significantly different ($p<0.05$), where the added evaporated milk and coconut milk improved the taste and flavour of the sinalab roducts. The Maillard-based sugar-peptide reaction that formed during the baking process was considered as the factor behind this difference in general acceptability.

Proximate Composition

The sensory acceptability of food products should be matched with their nutritional and energy values, especially when the product would be labelled for marketing. Thus the proximate composition of Premix Sinalab and its most acceptable baked product with evaporated milk were subjected for analysis as shown in table 2.

Table 2. Proximate composition of the prepared Premix *Sinalab* and baked *Sinalab* with evaporated milk.

Proximate composition (%)	*Sinalab* premix powder	*Sinalab* with evaporated milk
Moisture	10.48 ± 0.11	24.65 ± 0.12
Crude Fat	0.35 ± 0.01	3.40 ± 0.10
Crude Protein	0.93 ± 0.04	5.77 ± 0.16
Ash	0.27 ± 0.22	0.47 ± 0.02
Crude Fiber	1.73 ± 0.01	2.37 ± 0.02
Nitrogen Free Extract (Carbohydrates)	86.24	63.50

Note: Values are means of three replicates

The sinalab premix powder showed low moisture content of 10.48%, which was lower than the 14% miller's standard for wheat flour (NDSU, 2015). According to NDSU (2015), flour with greater than 14% moisture is susceptible to organism growth that leads to development of off odors and flavours. Therefore, the sinalab premix powder has good storability, especially when place in hermetically sealed aluminum stand-up pouch.

It was observed that Premix Sinalab did not have distinctive flavour. It did not have added flavouring agent, but when it was made into baked product with evaporated milk; its sensory attributes were improved. As such, the coconut milk and evaporated milk improved its sensory attributes. According to Wrolstad, et al. (2005) and Bradley (2010), the moisture content of the food influences its flavour, taste and appearance as well.

Despite the increase in the moisture content of the baked product with evaporated milk to 24.6%, studies revealed that diary-based flour products that are gluten-free showed (Moore, et al., 2004).

The sinalab premix powder has low crude fat content of 0.35%. According to NDSU (2015), the amount of fat present in a food product is a measure for storability, because product with high fat value can make it rancid through time (NDSU, 2015). Therefore, the sinalab premix powder could remain stable at room temperature at very low rate to become rancid.

On the other hand, the baked sinalab premix powder with evaporated milk showed a crude fat value of 3.40%. Fat, according to Zoulias, et al. (2002) improves the spreading of the flour dough and mouth feel, flavour intensity and richness of appearance of baked products. Thus, all the baked sinalab products had acceptable mouth feel may be due to the added vegetable oil during cooking, despite they were significantly different in terms of flavour intensity, colour and taste.

In terms of crude protein content, the sinalab premix powder showed 0.93% against 5.77% for baked sinalab with slimmed milk. According to the Wheat Marketing Center of Kansas State University (2008), the protein content of flour affects the flavour, texture and appearance of the baked products. Flour with low protein content is good in making crispy products and that with high protein content is good for chewy textured product like pan bread. Though arrowroot starch has low protein content, like the prepared sinalab premix, the added evaporated milk made its texture compact, chewy to gummy, aside from the fact that it improved the flavour / aroma and taste of the baked product.

Ash in flour is a factor for the presence of minerals in the sample, especially the essential minerals. According to Wheat Marketing Center of Kansas State University (2008), higher ash imparts stronger dough, more nutritious product and darker colour to the baked product. Typically, higher protein flours have higher ash content. This may be the reason why the baked sinalab products have pale colour—creamy to light brown, because the premix sinalab had ash content of 0.27%, while the baked sinalab with milk had 0.47%. These could be also related to the low protein content they had.

Both the sinalab premix powder and the baked sinalab with evaporated milk had love fiber content of 1.73% and 2.37%. According to Amir, et al. (2013), high fiber in flour makes the baked products dense and slightly brown in colour. Thus, the sinalab products are less dense and had creamy to light brown colour.

4. Conclusion

The island province of Marinduque is now known for different arrowroot delicacies, which have been sought both by the local and foreign tourists when they visited the province. Thus, product development for arrowroot delicacies has been one of the goals of the province. This project has been supported by the Department of Science and Technology-Region IV-B and the Department of Agriculture-Bureau of Agricultural Research.

This sinalab premix was developed by the School of Agriculture of Marinduque State College at Torrijos Campus, which can be easily made into sinalab by adding water, coconut milk and evaporated milk.

The sinalab premix made had low moisture content, fat, protein, ash and fiber, which can be made into baked products by simply adding coconut milk or evaporated milk, which can further enhance the product's texture, flavour or aroma and taste, as well as its nutritive value.

References

[1]. Amir, I. Z., Hanida, H. S. & Syafiq, A. (2013). Development and physical analysis of high fiber bread incorporated with cocoa (*Theobroma cacao* sp.) pod husk powder. *International Food Research Journal*, *20*(3), 1301-1305.
[2]. Andam, C. J. and Labay, P. M. (2010). Arrowroot farming and processing in Marinduque. Department of Science and Technology-Region IV-B, Philippines.
[3]. Aprianita, A., Vasiljevic, T., Bannikova, A., and Kasapis, S. (2014). Physicochemical properties of flours and starches derived from traditional Indonesian tubers and roots. *Journal of Food Science and Technology 51*(12), 3669-3679.
[4]. Association of Official Analytical Chemists. (2006). Official methods of analysis. Association of Official Analytical Chemists International (18th ed.), Gaithersburg, M.D.
[5]. Bakshi, A., Stephen, S., Borum, M. L. and Doman, D. B. (2012). Emerging therapeutic options for celiac disease: Potential alternatives to a gluten-free diet. *Gastroenterol. Hepatol. (NY)*, *8*(9), 582-588.
[6]. Bradley Jr, R. L. (2010). Moisture and total solids analysis. In *Food analysis* (pp. 85-104). Springer US.
[7]. Eichner, K., & Karel, M. (1972). Influence of water content and water activity on the sugar-amino browning reaction in model systems under various conditions. *Journal of Agricultural and Food Chemistry*, *20*(2), 218-223.
[8]. Fasano, A. and Catassi, C. (2001). Current approaches to diagnosis and treatment of celiac disease: An evolving spectrum. *Gastroenterology, 120*, 636–651.
[9]. Food and Drug Administration (FDA-USA) (2013). Consumer updates. Retrieved January 20, 2017 from http://www.fda.gov/downloads/ForConsumers/ConsumerUpdates/UCM363276.pdf
[10]. Gocmen, D., Inkaya, A. N. and Aydin, E. (2009). Flat breads. *Bulgarian Journal of Agricultural Science*, *15*(4), 298-306.
[11]. Izzo H. V. & Ho, C-T. (1992). Peptide-specific Maillard reaction products: a new pathway for flavour chemistry. *Trends in Food Science and Technology, 2*(3): 253 – 257.
[12]. Jyothi, A. N., Sheriff, J. T. and Sajeev, M. S. (2009). Physical and functional properties of arrowroot starch extrudates. *Journal of Food Science, 74*(2), E97-E104.
[13]. Kahlon, T. S. and Chiu, M. M. (2012). Whole grain gluten-free flat breads. *Cereal Foods World*, 57, 6-9.
[14]. Kahlon, T. S., and Chiu, M. C. M. (2014). Ancient whole grain gluten-free flat breads. *Food and Nutrition Sciences, 2014*
[15]. Kamaliroosta, L., Seyedian Ardebili, M., Asadi, G. H., Ghiassi Tarzi, B. & Azizinejad, R. (2016). Evaluation and comparison of qualitative properties of lavash bread types during storage by different techniques. *Nutrition and Food Sciences Research*, *3*(1), 57-70.
[16]. Kumalasari, I. D., Harmayani, E., Lestari, L. A., Raharjo, S., Asmara, W., Nishi, K., and Sugahara, T. (2012). Evaluation of immunostimulatory effect of the arrowroot (*Maranta arundinacea* L.) in vitro and in vivo. *Cytotechnology 64*(2), 131-137.
[17]. Martins, S. I., Jongen, W. M., and Van Boekel, M. A. (2000). *Trends in Food Science & Technology*, *11*(9), 364-373.
[18]. Moore, M. M., Schober, T. J., Dockery, P., & Arendt, E. K. (2004). Textural comparisons of gluten-free and wheat-based doughs, batters, and breads. *Cereal Chemistry*, *81*(5), 567-575.
[19]. North Dakota State University (2015). Wheat Quality & Carbohydrate Research. Dept. Plant Sciences, North Dakota State University, Fargo, North Dakota.
[20]. Pascua, A. M. (2015). Development and testing of an arrowroot (*Maranta arundinacea*) processing machine. School of Agriculture-Marinduque State College.
[21]. O'Brien, J., Morrissey, P. A., & Ames, J. M. (1989). Nutritional and toxicological aspects of the Maillard browning reaction in foods. *Critical Reviews in Food Science & Nutrition*, *28*(3), 211-248.
[22]. Ogasawara, M., Katsumata, T. & Egi, M. (2006). Taste properties of Maillard-reaction products prepared from 1000 to 5000Da peptide. *Food Chemistry*, *99*(3), 600-604.
[23]. Pourafshar, S., Rosentrater. K. A. and Krishnan. P. G. (2010). Malnutrition, a global problem, American Society of Agricultural and Biological Engineers (ASABE). Paper 10-08663. St. Joseph, MI: ASABE.
[24]. Shepherd, S. and Gibson, P, R. (2006). Understanding the gluten-free diet for teaching in Australia. *Nutrition and Dietetics*, *63*, 155-165.
[25]. Sinnamon, L. (2011). Arrowroot-a Plant with Many Uses. *Warm Earth*, (95), 30.
[26]. van Boekel, M. A. J. S. (2006). Formation of flavour compounds in the Maillard reaction. *Biotechnology Advances*, *24*(2), 230-233.

[27]. Wangen, S. (2009). Healthier without wheat. Seattle, WA, USA: Innate Health Publishing.
[28]. Watson, F., Stone, M., and Bunning, M. (2009). Gluten-free baking No. 9.376. Colorado State University Extension 4/09.
[29]. Welstead, L. (2015). The gluten-free diet in the 3rd millennium: Rules, risks and opportunities. *Diseases*, *3*(3), 136-149.
[30]. Wheat Marketing Center (2008). Wheat and flour testing methods: a guide to understanding wheat and flour quality, version 2. *Kansas State University*.
[31]. Wrolstad, R. E., Acree, T. E., Decker, E. A., Penner, M. H., Reid, D. S., Schwartz, S. J., ... & Sporns, P. (Eds.). (2005). *Handbook of Food Analytical Chemistry, Volume 1: Water, Proteins, Enzymes, Lipids, and Carbohydrates*. John Wiley & Sons.
[32]. Zoulias, E.I., Oreopoulou, V. & Tzia, C. (2002). Textural properties of low-fat cookies containing carbohydrate- or protein-based fat replacers. Journal of Food Engineering 55 (4), 337–342.

A Brief Author Biography

Ma. Edelwina M. Blase – An Associate Professor III from Pambujan, Northern Samar, Philippines. A graduate of the University of the Philippines Los Baños College Laguna in the course BS Food Technology in 1985, MS in Food Science in 2002 and Ph. D. in Food Science in 2011formerly, a researcher in the Institute of Food Science, UPLB wherein she handled two projects; textured vegetable protein (TVP) and coconut sap as beverage. She was also a Quality Control Inspector and Supervisor for ten years in a canning factory before she joined the academe in 1998 as an Instructor with subjects in food processing in the School of Agriculture, Poctoy, Torrijos, Marinduque. Her research expertise is inclined in product development of food from crops (fruits, vegetables, rootcrops, and cereals), meat and fish. Currently, she is involved in the product development of abalone and indian mango funded by DOST. Consequently, she is the Executive Director for Research and Development in the same College.

