CMU Journal of Science Vol. 20, No.3 (2016) 5-17

Sensory Acceptance of Loaf Bread as Affected by Yam flour, Margarine, and Oil

Domingo P. Lodevico[1], Ruby A. Arroyo[1], & Allene Mae V. Nasol[1]

[1]Department of Food Science, College of Human Ecology, Central Mindanao University, Musuan, Bukidnon, Philippines

ABSTRACT

Loaf bread is widely consumed, and its sensory acceptability is essential for consumers' quality assurance. Current trends in sensory techniques for cost-effective methods in food product development are the use of screening designs. This study investigated to identify the variables that affect significantly on the sensory acceptability of loaf bread processing. The design was composed of seven variables (refined sugar, fresh milk, salt, yam flour, oil, margarine, and yeast) with eight treatments using the combination of low and high levels of the variables following the Plackett-Burman 7x8 screening design pattern. Color, taste, aroma, texture and general acceptability of the loaf bread were evaluated using a 9.00 point Hedonic scale through 20 semi-trained panelists. SPSS 11.5 and Statistica 6.0 were used to analyze the data. Results revealed that lower levels of yam flour and margarine but with high levels of oil is preferred by most panelists pertaining to taste, aroma, texture, and general acceptability except the color of the loaf bread. Lowering the levels of yam flour and margarine but with high levels of oil improved the sensory attributes of the loaf bread. It is recommended that these levels of variables be used for loaf bread optimization designs.

Keywords: *Plackett-Burman, screening, sensory acceptability, loaf bread, yam flour*

INTRODUCTION

Developing countries are embarking composite flour studies in bread related processing primarily for economic purposes. Because of the global economic recession, attention is focused on substituting wheat flours in bread and other baked foods with locally cultivated crops (Oladunmoye et al., 2010). Wheat flour as a primary ingredient is being imported for most tropical countries which call for a substitute or at least partially replace with other raw materials. That is why researchers have conducted numerous composite flour studies using different materials to substitute wheat flour. Furthermore, composite flours have been used extensively to identify functional roles of flour components and test its sensory acceptability. Each component of composite flours is carefully selected to play a considerable role in contributing towards the nutritional or functional attribute of the product developed (Menon et al., 2014). Recent attempts include table potato (Murayama et al., 2015), mango kernel flour (Menon et al., 2014), banana (Braganza & Tolentino, 2013), chickpea (Gonzales et al., 2014), cocoyam (Eddy et al., 2012), yam bean (Kale et al., 2008), sweet potato (Trejo-Gonzalez et al., 2014), cassava (Shittu et al., 2007) and taro (Ammar et al., 2009) examining as well the reactions of composite flours on the organoleptic or acceptability of the product.

At present, literature in composite flours focusing on yam as a raw material for wheat flour substitution in bread processing is very limited. Even in Africa were yam is majority cultivated in million tons (Zhu, 2015), yam as a material in combination with other flours for loaf bread processing is still under intensive studies leading to commercial production. In the Philippines, a total of 13,798 metric tons of yam in 2015 is produced and continually grown (Philippine Statistics Authority, 2016) but the conversion of this crop into a more stable product such as composite flour for bread and other related pastry applications is less exploited, and thus, result of this study can be a benchmark for the local business enterprise.

Flour and bakery products are one of the major sectors which comprise the Philippine food and beverage processing industry. From 2014 to 2018 agri-food retail sales in the Philippines forecast, a 7.2% whereas from 2009 to 2013 showed only 6.1% (Minister of Agriculture and Agri-Food, 2014). Similar local reports on previous bread sales from 2012 to 2013 were also anticipated with an increase of 6-7% (Desiderio, 2013). However, the Philippines is highly dependent on imported agricultural raw materials and ingredients (USDA Foreign and Agricultural Service, 2014) which hinder to boost on incline production. This implies that composite

flour technology opens an avenue to solve cost issues on bread production.

In food product development, the sensory acceptance on the color, taste, aroma, texture and general acceptability of the product is the key to success. It is a measurement of the quality of bread so that it can compete with the existing commercial baked products in the market. The use of sensory evaluation as a technique for determining the acceptability or preference of a food product has been known for years. Moreover, conducting the sensory evaluation with a higher number of variables may consume time and demand a higher cost for producing the sample to be evaluated. Thus, the application of Plackett-Burman 7x8 screening design, a two-level statistical tool can be used to identify the significant variables that affect the production of bread which may lead to less experiment. In this paper, the focus is to identify the ingredient variables that affect significantly on the loaf bread's color, taste, aroma, texture, and general acceptability through Plackett-Burman 7x8 method.

METHODOLOGY

Two (2) different yam tubers VU-2 (purple) and NSIC GY-7 (slightly purple) were bought from a local farm in Lantapan, Bukidnon. Flour production was processed at Foods Laboratory in the College of Human Ecology, Central Mindanao University (CMU). The tubers were thoroughly sorted, washed and scrubbed to remove adhering soil. Cleaned yam tubers were steamed for 30-45 minutes followed by slicing in 1-centimeter thickness. Drying was done in a digital oven at 140-150°C and cooled before pulverizing. The flour produced was packed in a transparent polyethylene and sealed with a label. Optimum formulation of flour produced was used for bread production.

Loaf bread production was done at the University Food and Lodging Services (UFLS), CMU following the procedure of the sweetened loaf bread processing. All ingredients were weighed in a digital balance (Alpinum Classic TLB 2014001). The dry ingredients were mixed first followed by the wet ingredients. An electric roller kneader was used before molding into a cylindrical shape, and dough proofing was carried out for 3-4 hours. Baking was done at 250°F for 30 minutes. An extra 5 minutes cooling was given before slicing the bread. Ranges on the amount of ingredients used as values for Plackett-Burman 7x8 screening design (Table 1) were taken consideration from the original amount in sweetened loaf bread processing.

Table 1.
Plackett- Burman 7x8 coded and uncoded design for bread processing

Run/ Treatment	Variables						
	1	2	3	4	5	6	7
	Refined sugar (g)	Fresh milk (mL)	Salt (g)	Yam Flour (g)	Oil (mL)	Margarine (g)	Yeast (g)
1	+ (105)	+ (105)	+ (105)	+ (105)	+ (105)	+ (105)	+ (105)
2	+ (105)	+ (105)	+ (105)	+ (105)	+ (105)	+ (105)	+ (105)
3	- (100)	- (100)	- (100)	- (100)	- (100)	- (100)	- (100)
4	- (100)	- (100)	- (100)	- (100)	- (100)	- (100)	- (100)
5	+ (105)	+ (105)	+ (105)	+ (105)	+ (105)	+ (105)	+ (105)
6	- (100)	- (100)	- (100)	- (100)	- (100)	- (100)	- (100)
7	+ (105)	+ (105)	+ (105)	+ (105)	+ (105)	+ (105)	+ (105)
8	- (100)	- (100)	- (100)	- (100)	- (100)	- (100)	- (100)

[a]per ½ kilogram of UFLS sweetened loaf bread formulation

The sensory panel was composed of faculty, staff, and students from the College of Human Ecology for a total of 20 semi-trained evaluators. Eight samples, each coded with three digits were given to the evaluators to assess the sensory acceptability using the standard 9.00 point Hedonic scale (9.00=like extremely, 8.00=like very much, 7.00=like moderately, 6.00=like slightly, 5.00=neither like nor dislike, 4.00=dislike slightly, 3.00=dislike moderately, 2.00=dislike very much and 1.00=dislike extremely). The panelists were provided with water to rinse their mouths before and after tasting each sample.

Data obtained were subjected to Analysis of Variance (ANOVA), and means were separated by Tukey's Honestly Significance Difference Test through SPSS 11.5 while identification of the variables that significantly affect the sensory attributes of the loaf bread was elucidated through Pareto charts in Statistica 6.0.

RESULTS AND DISCUSSION

Acceptability of the loaf bread at all treatments using low and high levels at 25-50% replacement of yam flour produced a visible effect ranging from 2.95 to 7.90 which is equivalent to "dislike slightly" to "like very much" in the 9.00 point Hedonic scale (Table 2).

Table 2.
Summary on the Means of Sensory Acceptability during Screening

Treatment	Color*	Taste*	Aroma*	Texture*	General Acceptability*
1	3.95c	2.95c	3.70c	3.00c	3.10c
2	5.80abc	5.20b	5.25abc	5.80a	5.40ab
3	5.75abc	5.80ab	5.85ab	5.40ab	5.75a
4	4.35bc	3.25c	3.70c	3.75bc	3.60c
5	7.05ab	6.95a	6.25a	6.50a	6.85a
6	4.60bc	3.40c	4.35bc	3.60c	3.60c
7	4.55bc	4.20bc	4.10c	3.50c	4.05bc
8	7.90a	5.45ab	5.10abc	5.80a	6.00a

*Means in a column followed by different letters are significantly different using analysis of variance at the level of $p<0.05$; Tukey's honestly significance difference test.

Reports of previous studies as summarized by Ohimain (2014) that the acceptability of yam-wheat combination is at 20%. However, a higher percentage of yam flour acceptability in bread formulation investigated by Amandikwa et al. (2015) that 25% yam flour were statistically the same with 100% wheat bread. Nindjin et al. (2011) found out that 30% of yam starch substitution and 20% addition of cassava starch led to the composite bread which met consumer satisfaction on all attributes similar to that of the bread composed of white wheat flour as the control. This recent report is in agreement with the current data that 25% level of substitution of yam flour in loaf bread making is still acceptable. This explains the consistency on the higher acceptability given by the panelists to treatments 2, 3, 5 and 8 which contain 25% of yam flour (low levels).

Treatment 5 composed of low levels of margarine and yam flour revealed the highest acceptability of all sensory attributes except on the color which ranked second with a mean acceptability score of 7.05 equivalent to "like moderately" following treatment 8. However, treatment 8 which also contains low levels of margarine and yam flour but with low levels of oil showed a slight lower sensory acceptability on the taste and aroma in contrast to treatment 5. Possible explanation on this comparison may be due to the reaction of the oil levels added in the loaf bread during processing. According to the study conducted by Pasqualone et al. (2010) in cassava bread making, extra virgin olive oil significantly reduced the distinctive odor and flavor of cassava resulting to an intense fresh bread aroma, statistically not dissimilar to that of wheat bread. Thus, in the current study, treatments with high levels of oil have positive feedback to the panelists. Noting that treatment 1

with low levels of oil gave a consistent lowest acceptability score in all the sensory attributes tested.

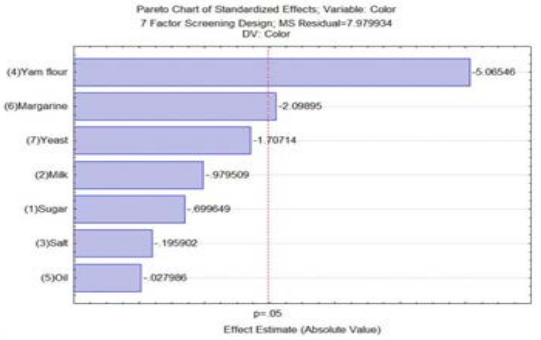

Figure 1. Pareto Chart on the Effect Estimates on the Color Acceptability of Bread

Both yam flour and margarine significantly influenced the color of the loaf bread with negative signs as depicted in Figure 1. This suggests that decreasing the amount of yam flour and margarine during loaf bread processing may result to a higher acceptability on the color of the product. Ukpabi (2010) discussed that at 30% lesser yam, food browning may occur enzymatically or non-enzymatically. This is well represented in Table 1 that treatment 8 showed the most acceptable rating with regards to color containing both low values of yam flour and margarine. Increasing the levels of these variables, some bread attributes became less acceptable. When yam flour and margarine substitution were at high levels, the color acceptability of the resulted bread decreased. Other authors using yam flour in composite bread and other related products found lower levels of satisfying yam flour added.

On the other hand, Nindjin et al. (2011) reported that the use of yam starch, cassava starch, and wheat composite flour affecting the crumb color and crumb appearance of the bread. The increased yam starch levels from 30 to 40% were still acceptable with no significant difference to the 100% wheat flour due to the advantage of greater purity of starch compared to its flour form. The major component of yam tubers is starch, which can amount up to 85% of total dry weight. Thus it is expected that starch quality is the determinative factor in the quality of yam food products (Zhu, 2015).

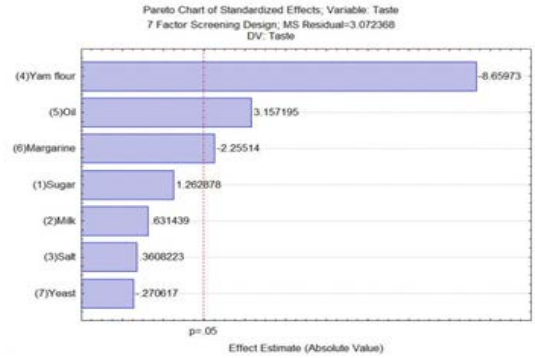

Figure 2. Pareto Chart on the Effect Estimates on the Taste Acceptability of Bread

The taste acceptability of the loaf bread was affected significantly by yam flour, oil, and margarine (Figure 2). A higher acceptability on the taste attribute of loaf bread can be achieved by lowering the levels of yam flour and margarine in contrast to oil. Brown (2011) pointed out that fats and oils contribute to the release of flavors and aromas of the food affecting the taste of the sample.

Although the availability of information is very limited on the taste acceptability of composite flours using yam, comparison of recent studies to other potential crops such as cassava has a similar pattern of 30% substitution in bread formulation declines acceptability (Ericksson et al., 2014). These results are also similar to those obtained by Begum et al. (2013) who investigated the sensory of maize flour in bread. Bread produced from 30 to 40% maize flour showed lower acceptability scores and significantly different from wheat bread but not significantly different from each other.

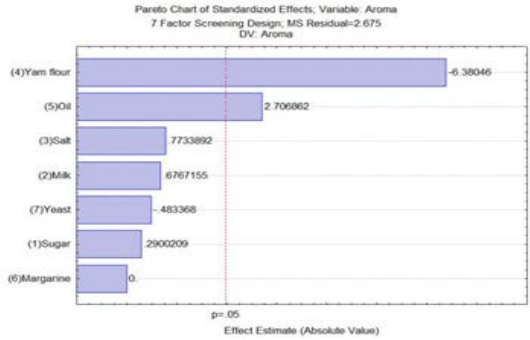

Figure 3. Pareto Chart on the Effect Estimates on the Aroma Acceptability of Bread

Increasing the levels of oil significantly affected the loaf bread's aroma with a higher acceptability (Figure 3). It is well exhibited in Table 2 that treatment 5 was observed to have the highest acceptability score of 6.25 followed by treatment 3 with an acceptability score of 5.85 equivalent to "like slightly" and "neither like nor dislike", respectively. These two treatments were composed of low yam flour levels as well as high levels of oil. Amandikwa et al. (2015) discussed that oil is important in bulking and consistency of products as well as baking applications. Oil absorption capacity is the ability of the flour protein to physically bind fat by capillary attraction, and it is of great importance since fat acts as flavor retainer and also increases the mouth feel of foods (Emmanuel et al., 2010). Oil gives soft texture and flavor to food thus, absorption of oil by food products improves palatability and flavor retention. Similar findings were also observed by Pasqualone et al. (2010) that the addition of extra virgin oil significantly reduced the distinctive cassava odor and flavor indicating that the virgin olive oil had the effect of rendering the cassava bread more similar to wheat bread without conferring proper characteristics.

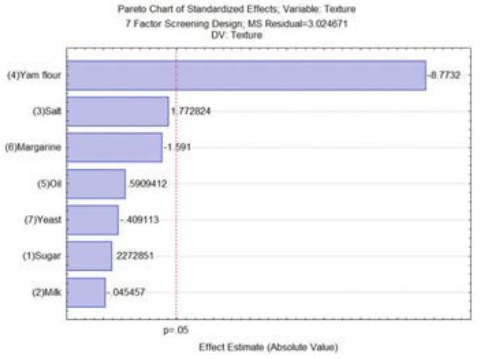

Figure 4. Pareto Chart on the Effect Estimates on the Texture Acceptability of Bread

The texture of the loaf bread (Figure 4) is solely affected by yam flour. Lower values of yam flour are preferred by most panelists. Most authors pointed out that texture in composite flours is affected entirely by the action of gluten. General comments expressed by the panelists for bread samples containing 30% cassava flour have been "compact," "sticky," "heavy" and "brittle" (Ericksson et al., 2014). Also, Begum et al. (2013) reported that texture of bread with a higher level of maize flour substitution was hard, dry and sandy due to maize flour containing no gluten which is responsible for bread sensory and baking quality. Pasqualone et al. (2010) also noted the presence of gummy texture, more sticky in the central

zone with poor internal regular properties of cassava bread compared to wheat bread as the control. Moreover, Otegbayo et al. (2007) reported that texture of fresh and stored yams in terms of stickiness or adhesiveness might be attributed to the moisture content and exudation of gelatinized starch. In this connection, lower value or 25% of yam flour applied in loaf bread was more preferred by the panelist probably due to the moderate amount of stickiness felt by the panelists compared to the commercial loaf bread. Most loaf bread nowadays locally produced are light in weight that panelist would also tend dislike. In contrast, the more yam flour applied, the heavier the product. This is because substitution of more than 30% will tend to have more moisture. Furthermore, Oladunmoye et al. (2010) added that the texture of the bread may be linked with damaged starch during milling and the degree of fineness of the flour.

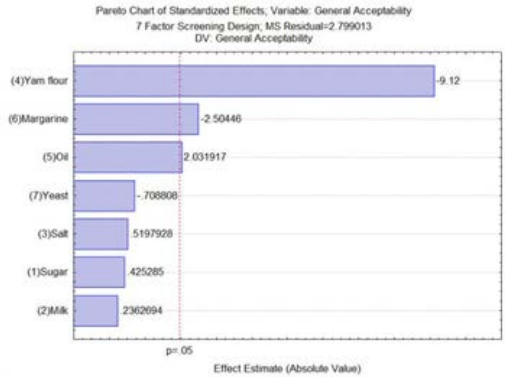

Figure 5. Pareto Chart on the Effect Estimates on the General Acceptability of Bread

General acceptability of the loaf bread (Figure 5) as affected significantly by yam flour, margarine, and oil indicates that the lower levels of yam (25%) flour and margarine (15g) with the high levels of oil (59mL) signify that treatment 5 suited the most acceptable treatment and is preferred by most panelists with the highest mean acceptability score of 6.85 approximately equivalent to "like moderately" in the nine-point Hedonic scale. The satisfying substitution level of yam flour in this study parallels within the range of previously most reported percentages in composite flour usage. In addition, this study found out that yam flour and margarine have the same effects in loaf bread processing in contrast to oil levels. As discussed earlier, oil significantly influenced other sensory attributes such as aroma and taste as observed between treatments 5 and 8 both contain low levels

of yam flour and margarine but differ in oil levels. Thus, following the suggestion of Pareto charts illustrated above will enhance the product and eventually attain its optimum general acceptability.

CONCLUSION

Plackett-Burman design played an important role in screening the variables that affect most in the loaf bread processing. Based on the Pareto charts elucidated, yam flour, margarine, and oil were the variables that significantly affect the process of loaf bread production. Generally, low levels of yam flour and margarine but with high levels of oil revealed to gain a higher sensory acceptability of loaf bread except on the color attribute with low levels of oil. This suggests that these levels may be taken into consideration as ranges in attaining the optimum formulation of yam loaf bread production using response surface three-level designs.

RECOMMENDATION

Further studies are required to accurately determine the response of the variables and its interactions using optimization three level designs to simply optimize consumer acceptability.

REFERENCES

Amandikwa, C., Iwe, M. O., Uzomah, A., & Olawuni, A. I. (2015). Physico-chemical properties of wheat-yam flour composite bread. *Nigerian Food Journal, 33*(1), 12-17.

Ammar, M. S., Hegazy, A. E., & Bedeir, S. H. (2009). Using of taro flour as partial substitute of wheat flour in bread making. *World Journal of Dairy & Food Sciences, 4*(2), 94-99.

Begum, R., Uddin, M. J., Rahman, M. A., & Islam, M. S. (2013). Comparative study on the development of maize flour based composite bread. *Journal of the Bangladesh Agricultural University, 11*(1), 133-139.

Braganza, M. L. T., & Tolentino, E. H. (2011). Banana (*Musa sapientum* var. Cavendish) flour as wheat flour extender in selected bakery products.

Brown, A. (2011). Understanding food principles and preparation. (4th ed.).

Desiderio, L. (2013). Bread sales to increase by 6 to 7%. *The Philippine Star*. Retrieved from http://www.philstar.com/headlines/2013/05/27/946805/bread-sales-increase-6-7.

Eddy, N. O., Essien, E., Ebenso, E. E., & Ukpe, R. A. (2012). Industrial potential of two varieties of cocoyam in bread making. *Journal of Chemistry, 9*(1), 451-464.

Emmanuel, C. I., Osuchukwu, N. C., & Oshiele, L. (2010). Functional and sensory properties of wheat (Aestium triticium) and taro flour (Colocasia esculenta) composite bread. *African Journal of Food Science, 4*(5), 248-253.

Eriksson, E., Koch, K., Tortoe, C., Akonor, P. T., & Oduro-Yeboah, C. (2014). Evaluation of the physical and sensory characteristics of bread produced from three varieties of cassava and wheat composite flours. *Food and Public Health, 4*(5), 214-222.

Gonzales, I. C., Quindara, H. L., Gonzales, F. R., & Botangen, E. T. (2014). Muffins and cookies produced from chickpea flour.

Kale, P. R., Karuniawan, A., & Pawelzik, E. (2008). Alternative Utilization of Storage Roots Flour of Yam Bean (*P. erosus*) in Wheat Flour-Based Food Products (Bread). Proceedings of the Mini Workshop Southeast Asia Germany Alumni Network (SEAG: Vol. 90. Empowering of Society through the Animal Health and Production Activities with the Appreciation to the Indigenous Knowledge. (p. 150). Manado-Indonesia. *Kassel University Press GmbH*.

Menon, L., Majumdar, S. D., & Ravi, U. (2014). Mango (Mangifera indica L.) kernel flour as a potential ingredient in the development of composite flour bread. *Indian Journal*

of Natural Products and Resources (IJNPR)[Formerly Natural Product Radiance (NPR)], 5(1), 75-82.

Minister of Agriculture and Agri-Food. Market Overview Philippines. (June 2014). Agriculture and Agri-Canada. Retrieved from http://www.agr.gc.ca/resources/ prod/ Internet-Internet/MISB-DGSIM/ATS-SEA/PDF/6509-eng.pdf.

Murayama, D., Kimura, T., Yuanrong, J., Tsuboi, K., Yamada, D., Santiago, D. M. & Yamauchi, H. (2015). Erratum: Applicability of dry flours produced from a table potato variety (*Solanum tuberosum L.* cv. May Queen) in bread making. Food Science and Technology Research, 21(4), 637-637.

Nindjin, C., Amani, G. N., & Sindic, M. (2011). Effect of blend levels on composite wheat doughs performance made from yam and cassava native starches and bread quality. *Carbohydrate Polymers, 86*(4), 1637-1645.

Ohimain, E. (2014). The prospects and challenges of composite flour for bread production in Nigeria. *Global Journal of Human-Social Science Research, 14*(3).

Oladunmoye, O. O., Akinoso, R., & Olapade, A. A. (2010). Evaluation of some physical–chemical properties of wheat, cassava, maize and cowpea flours for bread making. *Journal of Food Quality, 33*(6), 693-708.

Otegbayo, B., Aina, J., Abbey, L., Sakyi-Dawson, E., Bokanga, M., & Asiedu, R. (2007). Texture profile analysis applied to pounded yam. *Journal of texture studies, 38*(3), 355-372.

Pasqualone, A., Caponio, F., Summo, C., Paradiso, V. M., Bottega, G., & Pagani, M. A. (2010). Gluten-free bread making trials from cassava (Manihot esculenta Crantz) flour and sensory evaluation of the final product. *International Journal of Food Properties, 13*(3), 562-573.

Philippine Statistics Authority. (2016). CountrySTAT Philippines. Other crops: volume of production by crop and year. Retrieved from http://countrystat.psa.gov.ph/ selection.asp.

Shittu, T. A., Raji, A. O., & Sanni, L. O. (2007). Bread from composite cassava-wheat flour: I. Effect of baking time and temperature on some physical properties of bread loaf. *Food Research International, 40*(2), 280-290.

Trejo-González, A. S., Loyo-González, A. G., & Munguía-Mazariegos, M. R. (2014). Evaluation of bread made from composite wheat-sweet potato flours. *International Food Research Journal, 21*(4), 1683-1688.

Ukpabi, U. J. (2010). Farmstead bread making potential of lesser yam ('Dioscorea esculenta') Flour in Nigeria. *Australian Journal of Crop Science, 4*(2), 68.

USDA Foreign and Agricultural Service. Gain Report. (2014). Global agricultural information network. Philippines. Food Processing Ingredients.

Zhu, F. (2015). Isolation, composition, structure, properties, modifications, and uses of yam starch. *Comprehensive Reviews in Food Science and Food Safety, 14*(4), 357-386.