Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 9, Issue, 11, pp.61687-61690, November, 2017

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

DEVELOPMENT AND QUALITY EVALUATION OF PROCESSED MAKAPUNO BINAGOL USING DIFFERENT TYPES AND LEVELS OF SUGARS

[1]Leorna Marisel, A., *[2]Pantuhan Guillermo, P., [3]Pahm Sandra Joy, P., and [4]Castillo-Israel Katherine Ann, T.

[1]National Coconut Research Center-Visayas, Visayas State University, Visca, Baybay City, Leyte, Philippines
[2]Department of Agricultural Engineering, College of Agriculture, Mindanao State University – General Santos City, Philippines
[3]Graduate School, University of the Philippines, Los Baños, Laguna, Philippines
[4]Food Science Cluster, College of Agriculture, University of the Philippines, Los Baños, Laguna, Philippines

ARTICLE INFO

Article History:
Received 12th August, 2017
Received in revised form
27th September, 2017
Accepted 28th October, 2017
Published online 30th November, 2017

Key words:
Makapuno, Binagol,
Refined sugar,
Brown sugar,
Muscovado.

ABSTRACT

Makapuno binagol, a Philippine sweet dessert product, was processed using mature *makapuno* (VMAC5 variety). Meat from mature *makapuno* was initially shredded and steamed for 15 minutes. Refined, brown and muscovado sugar at 30%, 40% and 50% concentrations by weight were added to *makapuno* then mixed and soaked for 24 hrs before cooking. Finally, the cooked *makapuno* meat were packed inside coconut shell, sealed and sterilized at 15 psi for 15 min. The physicochemical, sensory and microbial properties of the *makapuno binagol* were evaluated using color and total soluble solids (TSS), 9-point Hedonic scale, and the total plate count. Results showed that the color and total soluble solids (TSS) of the product were affected by the types of sugar used, with the *makapuno* cooked in refined sugar having the lightest color and highest TSS. Sensory evaluation revealed that color and aroma acceptability were affected by neither types nor levels of sugar. Texture and general acceptability were affected by the sugar level only and the sweetness by both factors. General acceptability had strong positive correlations with all attributes, with aroma having the strongest correlation, followed by sweetness, texture and color; yet, color acceptability had no correlation with measured color values. The product developed was microbiologically safe (<10^5 CFU/g) after one month storage at room temperature.

Citation: Leorna Marisel, A., Pantuhan Guillermo, P., Pahm Sandra Joy, P. and Castillo-Israel Katherine Ann, T., 2017. "Development and quality evaluation of processed makapuno binagol using different types and levels of sugars", *International Journal of Current Research, Vol. 9, Issue, 11, pp.61687-61690, November, 2017*

INTRODUCTION

The *makapuno,* a mutant coconut, is characterized by an unusual condition of the endosperm. Unlike ordinary coconut wherein the cavity is filled with a watery liquid endosperm and whose solid endosperm is hard and crispy, the *makapuno* typically contains a viscous, white, translucent liquid endosperm and a soft glutinous to mushy solid endosperm which forms a much thicker layer at times filling up the whole cavity (del Rosario and de Guzman, 1981). Thus, it can classified as a coconut having a soft, tender and jelly-like meat. Its inner portion is a viscous liquid which is somewhat transparent or pellucid. Since it is known as a peculiar mutation of coconut, the *makapuno* commands a higher price in the market.

Corresponding author:* **Pantuhan Guillermo, P.,
Department of Agricultural Engineering, College of Agriculture, Mindanao State University – General Santos City, Philippines.

Visayas State University (VSU), spearheaded by Tessie C. Nuñez of the National Coconut Research Center-Visayas (NCRC-V), Baybay City, Leyte developed an almost 100% *makapuno*-yielding coconut trees, and established more than 50 ha. *makapuno* plantation in the country. Twelve hectares of which is located in Leyte and Southern Leyte and this excludes private individuals who planted a few numbers of *makapuno* trees in their backyard. The whole region of Leyte and Southern Leyte have no existing processing company involved in the manufacture of *makapuno*-based products except for few private individuals who utilized *makapuno* endosperm but only in small quantities. In addition, *makapuno* cannot be processed into copra unlike the normal coconut and the commodity is quite difficult to market in its fresh form because it gets spoiled easily. However, the crop offers a great potential in addressing food security and poverty alleviation because it is highly nutritious (Castillo, 1996; Lauzon, 2005). Realizing the great potential of *makapuno* as a good source of raw material not just in quantity but in quality as well, this research was conceptualized. The findings of this study will offer a great opportunity to provide a ready market for the crop, and eventually a potent source of income for both *makapuno* farmers and processors. In the end, this will help boost the *makapuno* industry in the country. Generally, this study aimed to develop *makapuno binagol* from VSU-developed *makapuno* variety (VMAC5). Specifically, this study aimed to process and evaluate *makapuno binagol* using different types and levels of sugar by assessing some physicochemical, sensory, and microbial quality.

MATERIALS AND METHODS

Mature *makapuno* meat from VMAC5 of about 9.5-10 months old was gathered from the experimental fields of the National Coconut Research Center-Visayas (NCRC-V), VSU, Visca, Baybay City, Leyte. The sugars (refined, brown and muscovado) were purchased at the local market of Baybay City, Leyte. Coco shells from Coconiño and/or VMAC1 were used as the primary packaging material of the products. The *makapuno* meat was steam-blanched for 15 min and soaked for 24 h in 30, 40, and 50% concentration in each of the refined, brown and muscovado sugar. After soaking, the *makapuno* meat was cooked with constant stirring in a pan. The cooked meat was then placed in a baking pan and dried for two and half hours at 70-75ºC. Afterwards, the product was packed in previously cleaned, sanitized, and dried coconut shells, and thus the term "binagol" (local term for coconut shell). The final product was subjected to sterilization using autoclave at 15 psi for 15 minutes for the purpose of prolonging product shelf life.

Three types of sugar (refined, brown and muscovado) and three levels (30, 40, and 50%) of each kind were used in formulating *makapuno binagol* following the Randomized Complete Block Design (RCBD). Least Square Difference (LSD) was used to locate significant means and Pearson correlation to correlate some significant parameters. For physicochemical evaluation of products, color was measured using the hand-held Pantone CAPSURE Color Matcher employing the CIE L*a*b* color values. Total soluble solids (TSS) was computed using readings in ^{o}Brix measured by a hand refractometer. Products were also subjected to sensory evaluation for acceptability (color, texture, aroma, sweetness and general acceptability) using 9-point Hedonic scale. An incomplete block design by Cochran and Cox (1957) Type II (t=9, k=6, r=8, b=12, E=0.94) was followed and replicated four times to make a total of thirty two (32) panelists evaluating the sample per treatment. Microbial quality was carried out by determining the total plate count of the sample in potato dextrose agar (PDA). Samples were taken from products stored for one month at room temperature.

RESULTS AND DISCUSSION

Physicochemical Properties

Color: Pantone CAPSURE Color Matcher was used in evaluating the color of the products and three color parameters (L*, a*, b*) were read. However, L* or the parameter that determines the lightness was used in the analysis. Table 1 presents the mean L* values of the *makapuno binagol* processed using different types and levels of sugar.

Table 1. Mean color values (L*) and total soluble solids (TSS) of *makapuno binagol* processed with different types and levels of sugar

Parameter	Type of sugar	SUGAR LEVEL		
		30%	40%	50%
Color value (L*)	Refined	40.09^{a}	44.21^{a}	46.60^{a}
	Brown	27.29^{b}	23.17^{b}	28.47^{b}
	Muscovado	18.33^{c}	16.73^{c}	15.02^{c}
Total soluble solids (TSS)	Refined	$37.66c^{g}$	44.57^{e}	47.80^{d}
	Brown	$35.40d^{h}$	38.52^{f}	46.27^{ee}
	Muscovado	34.54^{h}	44.00^{ef}	45.30^{e}

Means with the same letter are not significantly different at 5% using LSD.

Based on the results, there was a significant difference for L* values between the means of *makapuno binagol* processed with different types of sugar but not significantly affected by sugar concentration. All L* values were less than 50 which mean that they are below grey or neutral color. Muscovado produced the darkest color (almost black at 16.70 using the raw data) while the white sugar produced light greyish color (43.63 raw data). The different sugars varied in color due to the varying processing protocols performed, such as clarification and addition of molasses, in producing them (Wojtczak *et al*., 2012). Considered as plantation or unrefined brown sugar, muscovado is produced through backyard sugar mills and rudimentary cooking methods. Thus, sugarcane juice is not fully extracted and the sugar produced is not spared from too much sediment, resulting to its dark color. Moreover, the amount of molasses left or added back into the sugar during processing affected its color (Briones, 2003). On the other hand, refined sugar undergoes vigorous production involving milling, clarification, and bleaching with sulfur dioxide or carbonatation in order to produce a white product (Wojtczak *et al*., 2012). The concentration or level of sugar used in the *makapuno binagol* did not affect the color which implies that darker color is not imparted on the product when sugar concentration is increased.

Total Soluble Solids (TSS): Table 1 shows the mean total soluble solids (TSS) of the *makapuno binagol* which revealed that there was a significant difference among treatment means for both the types and levels of sugar used. The product processed using white sugar had the highest TSS, followed by muscovado, and lastly by brown sugar at the same concentration. This result further entails that white sugar best penetrates the *makapuno* meat during processing and thus resulting to high soluble solids in the product. This could be attributed to the relative size of sugar granules. White sugar has finer granules than brown or raw sugar, and hence, it dissolves more rapidly and penetrates better into food products (Sapolin, 1997). In terms of sugar level, the products processed with 50% concentration had the highest TSS while 30% had the lowest values. This is expected since the greater the amount of sugar used, the greater will be the soluble solids imparted into the product. In general, 50% white sugar had the highest TSS while product processed with 30% brown sugar had the lowest TSS.

Sensory Evaluation

Individual mean acceptability ratings for the parameters are shown in Table 2. Plots of the acceptability ratings of the *makapuno binagol* as affected by types and levels of sugar is also presented in Figure 1 for better comparison.

Table 2. Mean color, texture, sweetness, aroma and general acceptability ratings of *makapuno binagol* processed with different types and levels of sugar

Attribute	Type of sugar	SUGAR LEVEL		
		30%	40%	50%
Color Acceptability	Refined	6.69[a]	6.75[a]	6.69[a]
	Brown	7.38[a]	6.88[a]	6.69[a]
	Muscovado	6.44[a]	6.69[a]	6.13[a]
Texture acceptability	Refined	6.69[b]	6.25[cd]	5.94[d]
	Brown	6.88[b]	6.25[bc]	5.63[c]
	Muscovado	6.63[b]	6.63[b]	6.19[c]
Sweetness acceptability	Refined	6.94[e]	6.69[ef]	6.56[f]
	Brown	6.88[e]	5.94[g]	5.44[h]
	Muscovado	6.31[fg]	6.31[fg]	5.56[gh]
Aroma acceptability	Refined	7.13[i]	6.00[i]	6.31[i]
	Brown	6.75[i]	6.19[i]	5.75[i]
	Muscovado	6.13[i]	6.56[i]	5.88[i]
General acceptability	Refined	6.75[j]	6.38[jk]	6.13[k]
	Brown	6.94[j]	6.31[jk]	5.88[k]
	Muscovado	6.50[j]	6.63[j]	6.00[k]

Means with the same letter are not significantly different at 5% using LSD.

Color acceptability: As observed in Table 2, color acceptability rating was affected by neither type nor level of sugar. Color acceptability ranged from 6.13 to 7.38 which are between being “like slightly” to “like moderately” based on the 9-point Hedonic scale. This implies that panelists detected no significant difference in color acceptability of the *makapuno binagol* processed using different types and levels of sugar. Hence, whether light or dark in color, the products are still within acceptable level. Pearson correlation was also used to analyze the relationship between color acceptability and L* color values. The Pearson product-moment correlation coefficient (r) was found to be 0.181, indicating a very weak positive correlation. This indicates that there is no direct relationship between product color values and acceptability. This coincides with the statistical analysis asserting that difference in acceptability between lighter or darker products is not significant.

Texture acceptability: Based on Table 2, values for texture acceptability range from 5.63 to 6.88, or from “like slightly” to “like moderately” based on the 9-point Hedonic scale. Results revealed that texture acceptability was affected only by sugar level with 30% having the highest acceptability rating and 50% the lowest. This indicates that panelists observed no difference in texture caused by the use of different types of sugars. Instead, only sugar level showed apparent difference in the product texture acceptability. The amount of sugar in food affects texture by providing volume and consistency. Too much sugar may crystallize which leads to hard product, while too little sugar will cause failure of gelling process or very low consistency (Kusinska, 2007). In the present study, “makapuno binagol” with lower sugar content was found to possess more acceptable texture.

Sweetness acceptability: From Table 2, it can be observed that acceptability rating for sweetness was affected by both factors. In terms of type of sugar used, panelists preferred refined sugar over the brown and muscovado sugars. In terms of sugar level, 30% concentration received the highest acceptability, followed by 40% and lastly by 50%. Mean ratings ranged from 5.44 (neutral) to 6.94 (like moderately), with 30% refined sugar having the highest sweetness acceptability and 50% muscovado having the lowest. This finding conforms to the correlation of total soluble solids (TSS) against acceptability. From the computed Pearson product-moment correlation coefficient (r) of approximately -0.273, the TSS and sweetness acceptability had strong negative correlation, implying that there is lesser acceptability of products at higher sugar concentration.

Aroma acceptability: Similar to color, aroma was not affected by both types and levels of sugar. Panelists did not notice any difference in aroma of the various *makapuno binagol* products. Mean acceptability ratings for aroma ranged from 5.88 (like slightly) to 7.13 (like moderately), with refined sugar at 30% concentration had the highest value.

General acceptability: As shown in Table 2, general acceptability was found to be affected by sugar level only and not by the type of sugar. This indicates that panelists perceived that at the same concentration, *makapuno binagol* made from refined, brown and muscovado sugars have equal level of acceptability. Hence, any of the three types of sugar can be used in creating the final products. As to sugar concentration, the highest rating for general acceptability was computed on products using 30% sugar, while those processed with 50% sugar had the lowest rating. This implies that *makapuno binagol* with lower sugar level is generally more acceptable.
Figure 1 shows the correlation of general acceptability versus other acceptability parameters. Based on the graph, aroma had the highest Pearson product-moment correlation coefficient (r) of 0.751. It is followed by sweetness (r = 0.751), texture (r=0.518), and lastly by color (r=0.499). This means that aroma had the highest influence on the general acceptability of the product. However, as previously discussed, aroma as well as color acceptability were neither affected by type nor level of sugar. On the other hand, sweetness and texture acceptability were both influenced by sugar level. This simply conforms to the observation that only the sugar concentration used in making the products influenced the panelists’ perception in rating the general acceptability.

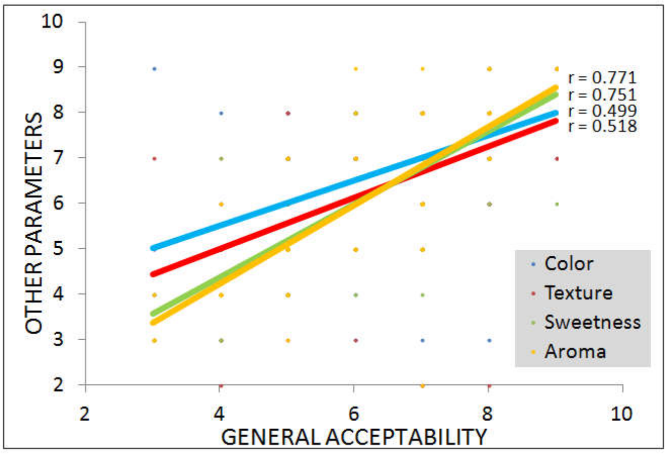

Figure 1. General acceptability correlation with other attributes of *makapuno binagol*

Microbial Quality

Acceptable limit of standard plate counts for ready-to-eat foods (all components are fully cooked for immediate sale or consumption) is $<10^5$ CFU/g (NSW Food Authority, 2009). From Table 3, it appears that all products were still within this acceptable level after one month of storage at room temperature.

Table 3. Microbial evaluation of the *makapuno binagol* processed with different types and levels of sugar

Type of sugar	Sugar Level		
	30%	40%	50%
	Total plate count (CFU/g)		
Refined	39,500	32,500	57,500
Brown	240	150	19,500
Muscovado	240	290	18,500

Conclusion

Processed *makapuno binagol* using different types and levels of sugars showed different color (L*), but were significantly affected by levels of sugar rather than the type, with 50% muscovado sugar having the lowest L* value. Total soluble solids were both affected by type and level of sugar, with 50% level having the highest value, and refined sugar among the sugar types. Overall, general acceptability of *makapuno binagol* was influenced by the sugar level only and not the type of sugar. This indicates that as the concentration of sugar is increased, product acceptability (texture, sweetness and general acceptability) decreases. All treatments were also found to be microbiologically acceptable after one month of storage at room temperature.

Acknowledgment

The authors would like to thank Ms. Nelissa A. Sudaria, Ms. Johanna Codog, Ms. Alma Sudaria, Ms. Elvie Quintana, Mr. Rodel Alcos, Engr. Nilo L. Leorna, Prof. Tessie C. Nuñez, and all the staff of the National Coconut Research Center-Visayas, Visayas State University, Visca, Baybay City, Leyte and the Food Science Cluster, College of Agriculture, UP Los Banos.

REFERENCES

A.O.A.C. 1980. Official Methods of Analysis. In American Association of Analytical Chemists (13th ed.). Washington, D. C.

Briones, M.R. 2001. Muscovado: the promise of the 'other sugar'. *Bureau of Agricultural Research* (BAR) Digest 3 (3).

Castillo, E.A. 1986. Chemical characterization of normal coconut and makapuno endosperms. Laguna, Phileppines: University of the Philippines at Los Baňos, Laguna, PhD dissertation.

Cochran, W. G. and Cox, G. M. 1957. Experimental design (2nd ed), p. 376. New York: Wiley and Sons Inc.

Del Rosario A.G. and de Guzman, E.V. 1981. Growth promoting and cytokinin-like substance of makapuno and non makapuno coconut endosperm. *Philippine journal coconut studies:* 20-29.

Food and Agriculture Organization of United Nations (FAO). 1995. Fruit and vegetable processing. In FAO Agriculture Service Bulletin, p. 15, 49, 81-82, 119. Rome, Italy: FAO.

Heid, J. L. and Joslyn, M. A. 1983. Food processing operation: their management, machine, materials, and methods. p. 237, 558-559. Westport, Connecticut: AVI Publishing Company, Inc.

Jaworski, S. 2014. Sugar. Downloaded from: http://www.joyofbaking.com/sugar.html.

Kusinska, E. 2007. Effect of sugar addition on textural properties of the half-short cake. *Polish Journal of Food and Nutrition Sciences* 57 (2A): 107-110.

Lauzon, R.D. 2005. Physico-chemical properties and processing possibilities of macapuno cultivars developed at Leyte State University. *Philippine Journal of Crop Science Society of the Philippines* (PJCS) (30)2: 55-60.

Ly, T. and Rubio. 1983. State of the art coconut research and development. National Science and Technology Administration: 21.

NSW Food Authority. 2009. Microbiological quality guide for ready-to-eat foods: a guide to interpreting microbiological results. Downloaded from www.foodauthoruty.nsw.gov.au

Nuñez, T. C. 1995. Agronomic characteristics of F2 pure makapuno palm. *Philippine Journal of Crop Science* 19(1): 69.

Ramirez, P. A. and Mendoza, E. M. T. 1998. The makapuno mutant coconut. In The National Academy of Science and Technology (Philippines), p. 1-27. Manila, Philippines:

Sapolin, D. 1997. Other sweeteners to use. Vegetarian Times 244: 38-39.

SAS. 1985. SAS User's Guide: Statistics Version (5th ed). Cary, NC: SAS Institute, Inc..

Wojtczak, M., Biernsiak, J. and Papiewska, A. 2012. Evaluation of microbiological purity of raw and refined white cane sugar. *Food Control* 25 (1): 136-139.

****