Sweetpotato Product Development: Modified Yoghurt, Hopia and Vinegar

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Abstract

Three sweetpotato entries namely JO6 30-3 (yellow colored flesh), Immitlog (orange colored flesh) and Haponita (violet colored flesh) were evaluated for their acceptability when added to yoghurt as flavoring hopia as filling and vinegar as fermenting material. The product development was done from October 2010 to July 2013.The varieties were found to be acceptable for the production of yoghurt, hopia and vinegar. Yoghurt and hopia has good taste, sugar just right and texture is smooth for yoghurt. Sweetpotato yoghurt can have a shelf-life of one month under refrigerated condition, hopia for seven days under room temperature conditions ranging from 24 – 26 °C and relative humidity from 70-80%.

Vinegar is acceptable at six months but has a better taste when aged longer, one year or more with a pH of 3.4.Addition of yellow, orange and violet fleshed sweetpotato increases energy, carbohydrates, vitamin A and calcium of yoghurt and vitamin A and calcium of hopia.With an estimated production cost of Php 33.06, Php 25.78, and Php 23.98 for yoghurt, hopia and vinegar, the computed return on cash expense for yoghurt is 25.52%, 25.10% for hopia and 25.13% for vinegar if the wholesale price is PhP 41.50 (yoghurt), PhP 32.25 (hopia) and Php30 (vinegar).

Keywords: Sweetpotato, processing, development

Introduction

The most obvious link between health and agriculture are the nutritional and health status of the population. The national government through the Department of Agriculture has been promoting production of root crops as one strategy of attaining self-sufficiency (Bautista, 2013).

Sweetpotato, depending on the variety contains high amount of vitamin A, C and minerals such as calcium. Orange-fleshed varieties are rich in beta-carotene, and purple-fleshed varieties are rich in anthocyanins, both of which are popular dietary antioxidants (Teow *et al.* 2007).

Antioxidants are thought to reduce the harmful effects of oxidative stress, and prevent development of chronic diseases (such as heart disease, or cancer).

Sweetpotato contains anti-oxidants that include phyto-chemical and anthocyanin substances as nutraceuticals. Anti-oxidants extracted from fermented sweetpotato were found more stable and pure than other food crops (Danielle, 2007). This report gave notion for using sweetpotato as a natural source of anti-oxidants in the food industry. Beta-carotene rich (yellow and orange fleshed) sweetpotato is one of a few new crops which is an excellent source of energy and important nutritive substances that can contribute to improve the nutrient status of communities.

The crop is being promoted in developing world as a source of pro – vitamin A towards alleviating Vitamin A deficiency (Laurie and Van Hearden, 2012)

Antioxidant anthocyanin pigments are abundant in purple or violet fleshed sweetpotato. Consuming a purple sweetpotato may prevent colon cancer by modulating antioxidant status, Soyoung, 2012.

Recently because of the high incidence of cancer and diabetis, efforts are being done to promote consumption of health promoting food products.

Vitamin A deficiency is one of the malnutrition problems in the Philippines. In Mozambique, children intake of vitamin A increased with increased commercialization of orange fleshed sweet potatoes.

Using the yellow, oranged and violet flesh sweetpotato as based for yoghurt and hopia could improve the nutritional value of the product since ithas high potential in vitamin A and anthocyanin that can serve as strategy for improving human health.

MATERIALS AND METHOD

Variety evaluation of sweetpotato for yoghurt, hopia and vinegar. Yellow (JO6 30-3), orange (Immitlog) and violet (haponita) fleshed sweetpotatoes were used for producing yoghurt, hopia and vinegar.

For yoghurt, a yoghurt base was made by fermenting pasteurized cow's milk which was combined with a sweetpotato component comprising of sweetpotato and sugar.

For hopia, sweetpotatoes were boiled, mashed and mixed with milk and sugar, cooked until thick and used as filling.

For vinegar, sweetpotato peelings from those used for yoghurt and hopia were boiled until cooked. The broth was added with sugar, cooled to lukewarm and added with yeast. Mother vinegar was added after seven days of fermentation.

Sensory evaluation was done to determine the acceptability of JO6 30-3 (yellow), immitlog (orange), and haponita, (violet) fleshed for yoghurt, hopia and vinegar.

Sensory evaluation form was distributed to a definite number of respondents for them to fill up by rating the products using the hedonic rating scale from 1 – 7 (1-dislike very much, 2- dislike slightly, 3-dislike moderately, 4-niether like nor dislike, 5-like slightly, 6-like moderately and 7-like very much). Standardization and modification of the product based on consumers' response

The products developed under laboratory conditions were mass produced and delivered to the BSU marketing center and organic market to gather consumers' comments which served as the basis for standardization or modification of the products.

Based on the result of the market testing. The product was modified to suit the consumers' preference. The modified product served as the basis for nutrient analysis, product costing and market acceptability. Sales turnover was also recorded.

Storability

Shelf life was determined by counting the number of days from storage to when a noticeable change in the sensory attribute (smell and flavor) was observed. This was done by destructive sampling for yoghurt and hopia.

The products were monitored daily to determine the taste quality of each product. Occurrence of mold was also monitored and recorded through visual observation and the use of magnifying glass. For yoghurt, the basis for spoilage is the change of fluidity.

Nutritional Analysis

Nutrient content of the modified formulation for sweetpotato based yoghurt and hopia were determined by adding the nutrient content of the product ingredients which were computed based on the Philippine Food Composition Table (FNRI 1997). (Note: products were not subjected to actual chemical analysis because its too expensive, no budget).

Product Cost and income derived from sweetpotato based yoghurt, hopia and vinegar

Product costing and income derived from the potential formulation were estimated. Estimates were based on the cost of ingredients, labor, cooking time, packaging, fuel and overhead cost.

Sales Turn-over

A record book was maintained where products delivered and product sales are recorded. Sales turn-over was monitored and recorded. Monitoring was done on a weekly basis.

RESULTS AND DISCUSSION

Suitability of using yellow (JO6 30-3), orange (Immitlog) and violet (Haponita) fleshed sweetpotatoes for yogurt.

The yellow (JO6 30-3), orange (Immitlog) and violet (Haponita) fleshed sweetpotato varietes for yoghurt gave an acceptable rating of 6 and 7 which is like moderately to like very much (Table 1). To improve the quality, a finer texture of the sweetpotato is recommended for haponita.

Acceptability of using yellow (JO6 30-3), orange (Immitlog) and violet (Haponita) fleshed sweetpotatoes as filling for hopia

Sweetness and flavor of camote hopia was rated as like very much (7) by the panelist. This is because the sweetness is just right (not so sweet and not so bland) and the flavorgood (Table 2).

The dough is attractive and flaky although it is oily. Variety affected the general acceptability of the product. JO6 30-3 gave the highest rating of 7 like very much and this might be due to the yellow color of the variety.

Acceptability of using yellow (JO6 30-3), orange (Immitlog) and violet (Haponita) fleshedsweetpotatoes for vinegar

Sweetpotato varieties affected the general acceptability of the vinegar. Although the rating was from like slightly, 5 to like very much, 7 after six months of aging, using the yellow and the violet variety of sweetpotato for venigar has the highest acceptability rating of 7, like very much (Table 3).

According to the panelists, using these varieties gave a good aroma and nice color. The acceptable color could be attributed to the red color of vinegar from haponita. Lack of sourness (pH 3.7) for variety immitlog might be the reason why it has the lowest rating of 5 like slightly.

However, aging the vinegar for one year (Table 4) gave a better/higher acceptability for the three sweetpotato varieties evaluated since equal pH of 3.4 and clearer quality was observed .

Vinegar has an acid pH that ranges from 2 to 3.5; the ones used for cooking typically have a pH of 2.4(http://www.essortment.com/health-benefits-yogurt-48448.html).

The sweetpotato–based vinegar has an acid pH ranging from 3.4 – 3.7 which is comparable to other commercial vinegar in the market. Apple cider vinegar, an all-natural choice for food has a pH typically between 4.5 – 5 if undiluted (Wikipedia, the free Encyclopedia).

Table 1. Sensory characteristics of sweetpotato-based yoghurt

SP Varieties	Parameters: Appearance	Color	Texture	Flavor	Sweetness	Viscosity	General Acceptability
JO6 30-3	6	6	7	6	6	6	6
Immine**tlog**	6	6	7	6	6	6	6
Haponita	6	6	5	6	6	6	6
LSD .05	ns	ns	ns	ns	ns	ns	ns
CV%	7.27	10.62	4.87	7.27	4.26	7.05	6.58

Sensory rating scores: 7 – like very much, 6 – like moderately, 5 – like slightly, 4 – neither like nor dislike, 3 – dislike slightly, 2 – dislike moderately, 1 – dislike very much

Table 2. Sensory characteristics of sweetpotato-based hopia

SP Varieties	Parameters: Appearance	Color	Texture	Flavor	Sweetness	General Acceptability
JO6 30-3	6	6	6	7	6.93	6.93
Immitlnmet**og**	6	6	6	7	6.93	6.06
Haponita	6	6	6	6.93	6.87	6.00
LSD .05	ns	ns	ns	ns	ns	**
CV%	10.29	10.85	9.20	2.14	4.43	7.23

Sensory rating scores: 7 – like very much, 6 – like moderately, 5 – like slightly, 4 – neither like nor dislike, 3 – dislike slightly, 2 – dislike moderately, 1 – dislike very much

Table 3. Sensory characteristics of sweetpotato-based venigar aged for 6 months

SP Varieties	Parameters: Appearance	Color	Sourness	Flavor	General Acceptability	pH
JO6 30-3	6	6	5.93	6.93	6.73	3.4
Immitne**log**	6	6	5.87	6.93	5.53	3.7
Haponita	6	6	5.87	6.87	6.93	3.4
LSD .05	ns	ns	ns	ns	**	
CV%	9.27	8.85	5.76	4.43	7.26	

Sensory rating scores: 7 – like very much, 6 – like moderately, 5 – like slightly, 4 – neither like nor dislike, 3 – dislike slightly, 2 – dislike moderately, 1 – dislike very much

Table 4. Sensory characteristics of sweetpotato-based venigar aged for 12 months

SP Varieties	Parameters: Appearance	Color	Sourness	Flavor	General Acceptability	pH
JO6 30-3	7	7	7	7	7	3.4
Immine**tlog**	7	7	7	7	7	3.4
Haponita	7	7	7	7	7	3.4

Sensory rating scores: 7 – like very much, 6 – like moderately, 5 – like slightly, 4 – neither like nor dislike, 3 – dislike slightly, 2 – dislike moderately, 1 – dislike very much

Standardization and modification of product formulation

Sweetpotato – based yoghurt, hopia and vinegar were delivered for sale to the BSU Organic and marketing Center to observe their market potentials and to gather consumers response. According to consumers, sweetpotato yoghurt has good taste, sugar is just right, viscosity is alright but the texture is not fine (haponita variety) and flavor is not so good (too much or very pronounced sweetpotato flavor). For sweetpotato hopia, taste is good, sugar is just right, but has oily dough. Vinegar has a good taste but maybe better/clearer in appearance when aged longer.

Based on the consumers' comments, the formulation was modified; mashed sweetpotato was lessened from 29% to 19%. Yoghurt texture was improved. Oil crust was lessened for hopia.

After modification of the formulation, the product was continuously delivered to the same market outlet. Comments from the consumers were likewise noted.

Table 5. Consumers ' response on the original formulation

Formulation Ratio	Comments
Yoghurt - 29% sweetpotato	Good taste, sugar just right, viscosity is okay, but the texture is not fine for the violet colored yoghurt and sweetpotato is too much. If possible, lessen the sweetpotato.
Hopia	Taste is good, sugar is just right, dough is flaky but it is oily, if possible lessen the oil.
Vinegar	Good taste, but maybe better when aged longer.

Table 6. Consumers' response on the modified formulation

Formulation Ratio	Comments
Yoghurt -19% sweetpotato	Good taste, sugar just right, viscosity is okay and the texture is smooth for the violet colored yoghurt and sweetpotato flavor was not so pronounced.
Hopia	Taste is good, sugar is just right, dough is crunchy and oil was lessened.
Vinegar	Excellent, better in taste

Based on the interviews done, the modified formulation had satisfied the consumers. Sweetpotato yoghurt (violet flesh) has a smoother texture and sweetpotato flavor was lessened or not so pronounced. Sweetpotato hopia has less oil, crust is flaky and sweetness is just right. Vinegar, when it was aged for one year has better/ more sour in taste so that it has an excellent quality orthe appearance is much clearer as commented by the buyers.

Shelf-life of yoghurt and hopia

Shelf-life is the length of time a product maybe stored without becoming unsuitable for use or consumption (Wikipedia, the free encyclopedia). Sweetpotato yoghurt can maintain its original quality (smooth texture and nice color) in taste unopened for a period of one month under refrigerated conditions, after which the yoghurt spoils. Hopia can be stored for seven days properly sealed at room temperature conditions ranging from 24 – 26 °C and relative humidity of 70 – 80%.

Table 7. Shelf-life ofyoghurt and hopia

Products	Shelf-life	Expiration date
Yogurt	30 days (refrigerated)	25 days
Hopia	Seven days at room temperature	5 days

Production Cost for Yoghurt, Hopia and Vinegar

Product costing was based on the improved and acceptable formulations by the consumer/buyers (Tables 8, 9 and 10). The production cost in processing sweetpotato based yoghurt, hopia and vinegar is shown in table 7, 8, and 9. It was computed based on the prevailing market price (2013). Production cost includes, the raw materials, fuel, electricity, packaging materials, labor and other expenses.

Based on our monthly production, the different products yielded about 104 bottles (375 ml) yoghurt, 144 packs (4 pieces per pack) of hopia and 85 bottles (350 ml) of sweetpotato vinegar. The estimated production cost for sweetpotato yoghurt is 33.06, hopia is 25.78 and vinegar is 23.98. At a wholesale price of 41.50 for yoghurt, 32.25 for hopia and 30.00 for vinegar, the computed return on cash expense is 25.52%, 25.10% and 25.13% respectively.

Table 8. Production cost and estimated Return on Cash Expense for Sweetpotato Yoghurt

Ingredients	Quantity	Unit cost(Php)	Total cost(Php)
Fresh milk (liters)	32	60.00	1,920.00
Yoghurt culture (Tbsp)		78.00	156.00
Full cream powdered milk (Tbsp)	60	1.70	102.00
Sweetpotato (cup)	10	8.33	83.33
Sugar (cup)	10	7.04	70.40
Vanilla (tsp)	4	0.50	2.00
Fuel		10.00	20.00
Container	104	2.90	301.60
Transportation		150.00	300.00
			2,955.33
Other expenses (10%)			295.53
			3,250.87
Labor, hours	5	37.50	187.50
Total Production Cost			3,438.37
Production cost/bottle			33.06
Whole sale price			41.50
Output (pcs)	104	41.50	4,316.00
Production cost			3,438.37
Net income			877.63
Return on cash expense (%)			25.52

Table 9. Production cost and estimated Return on Cash Expense for Sweetpotato Hopia

Ingredients	Quantity	Unit cost(Php)	Total cost(Php)
Sweetpotato (kg)	16	25.00	400.00
Flour, 3rd class (cup)	4	3.89	15.56
Condensed milk (can)	16	28.00	448.00
Full cream powdered milk (cup)	2	27.22	54.44
Sugar (cup)	1	7.04	7.04
Vanilla (tsp)	8	0.50	4.00
Margarine (cup)	4	33.50	134.00
All purpose flour (kg)	8	43.00	344.00
Oil (cup)	10	18.94	189.40
Egg (pieces)	8	5.00	40.00
Fuel & electricity		25.00	200.00
packaging	144	5.00	720.00
			2,556.44
Other expenses (10%)			255.64
			2,812.08
Labor, hours	24	37.5	900.00
Total Production Cost			3,712.08
Production cost/pack			25.78
Whole sale price			32.25
Output (pks)	144		4,644.00
Production cost			3,712.08
Net income			931.92
Return on cash expense (%)			25.10

Table 10. Production cost and estimated Return on Cash Expense for Sweetpotato Vinegar

Ingredients	Quantity	Unit cost(Php)	Total cost(Php)
Sweetpotato (kg)	16	25.00	400.00
Flour, 3rd class (cup)	4	3.89	15.56
Condensed milk (can)	16	28.00	448.00
Full cream powdered milk (cup)	2	27.22	54.44
Sugar (cup)	1	7.04	7.04
Vanilla (tsp)	8	0.50	4.00
Margarine (cup)	4	33.50	134.00
All purpose flour (kg)	8	43.00	344.00
Oil (cup)	10	18.94	189.40
Egg (pieces)	8	5.00	40.00
Fuel & electricity		25.00	200.00
packaging	144	5.00	720.00
			2,556.44
Other expenses (10%)			255.64
			2,812.08
Labor, hours	24	37.5	900.00
Total Production Cost			3,712.08
Production cost/pack			25.78
Whole sale price			32.25
Output (pks)	144		4,644.00
Production cost			3,712.08
Net income			931.92
Return on cash expense (%)			25.10

Nutrient Content of Sweetpotato Based Yoghurt and Hopia

The nutritional content of sweetpotato–based yoghurt and hopia is shown in Tables 11 and 12. Nutritional computation was based on the FNRI Food Composition Tables 1997 (chemical analysis is too expensive, no budget). Yoghurt and hopia with yellow, orange fleshed sweetpotato particularly JO6 30-3, Immitlog and Haponita (violet fleshed), was observed to have a slight difference in all the computed nutrients.

Sweetpotato based yoghurt with yellow, orange and violet fleshed sweetpotato (Table 10) contains higher amount of vitamin A (164.98 and 146.65 ug RE), energy (325.17 and 321.34 kcal), carbohydrate (33.95 and 33.45 g) and calcium, (587.17 and 583.84 mg) per 375 ml of yoghurt. Compared with the plain yoghurt which has lower nutrient content of 92 Ug RE for Vitamin A, 83 kcal for energy, 5.4g for carbohydrates and 180mg for calcium.

Hopia with yellow, orange and violet fleshed sweetpotato as shown in (Table 11) has a higher amount of vitamin A (43 and 33.84 ug RE) and calcium (59.05 and 57.38 mg) and with perceived lower fat content (6.96 g), which is healthier as compared with the commercial 'hopyang baboy'.This result indicates that yoghurt and hopia with sweetpotato either yellow, orange and violet fleshed can give higher vitamin A and calcium.

Sales Turnover of Sweetpotato Based Yoghurt, Hopia and Venigar

Out of the 648 (375ml) bottles of sweetpotato yoghurt sold in 2012, 305 bottles were sold during the first six months of said year while 353 bottles of equal content were sold from January to June of 2013. In 2012 and 2013,101 and 134 (350ml) bottles of sweetpotato vinegar were sold respectively while 367 packs (4 pcs of 47g each per pack) of sweetpotato hopia were sold from January to June of 2013.

There is a 15.74% (48 bottles) increase in the number of bottles sold for yoghurt as well as a 32.67% (33 bot) increase for vinegar for the first six months of 2013.

Records show that these products have potentials for commercialization. However, to provide a more realistic data to show its potential for commercialization, outlets will be increased for market testing of the products.

Table 11. Nutrient Content of Sweetpotato-based yoghurt, 375 ml

Nutrient	Plain yoghurt	ImmiInet**tlog** (deep yellow)	Haponita (violet)
Energy (kcal)	83	325.17	321.34
Protein (g)	5.3	13.88	13.93
Carbohydrates (g)	5.4	33.95	33.45
Fat (g)	(4.5)	14.61	14.57
Vitamin A (Ug RE)	92	164.98	146.65
Calcium (mg)	180	587.17	583.84

Note: Nutrient content of plain yoghurt was lifted up from the Philippine Food composition Tables, FNRI 1997

Table 12. Nutrient Content of Sweetpotato-based hopia per 47.4g

Nutrient	HopyangBaboy	ImInn**m**itlogetlog (deep yellow)	Haponita (violet)
Energy (kcal)	41.4	181.54	180.29
Protein (g)	5.0	3.23	3.35
Carbohydrates (g)	69.1	25.01	24.76
Fat (g)	13.1	6.96	6.94
Vitamin A (Ug RE)	15	43.0	33.84
Calcium (mg)	32	59.05	57.38

Note: Nutrient content of plain yoghurt was lifted up from the Philippine Food composition Tables, FNRI 1997

Table 13. Sales Turnover of Sweetpotato Based Yoghurt, Hopia andVinegar

Products/year	Jan. – June of 2012	Jan. – June of 2013
Yoghurt (375 ml capacity)	305	353
Hopia, (pks, 4 pcs 57g)	-	367
Vinegar (350 ml capacity)	101	134

SUMMARY AND CONCLUSION

Three sweetpotato entries namely JO6 30-3 (yellow colored flesh), Immitlog (orange colored flesh) and Haponita (violet colored flesh) were evaluated for their acceptability for yoghurt, hopia and vinegar. October 2010 to July 2013.

JO6 30-3 (yellow colored flesh), Immitlog (orange colored flesh) and Haponita (violet colored flesh) have good sensory characteristics but with slight modifications based on the costumers/buyers comments like: improve sweetpotato texture and flavor for yoghurt, lessen the dough oil for hopia and longer aging for vinegar.

However, when formulations were modified based on these comments, texture of yoghurt becomes smooth, flavor was lessened so that sweetpotato flavor was not so pronounced and oil was lessened for the dough of the hopia. Aging for vinegar was longer giving a more sour taste and clearer appearance of the products.

The computed production costs for sweetpotato yoghurt, hopia and vinegar were Php33.06, Php25.78 and Php26.24, respectively.

At a wholesale price of Php 41.50 for yoghurt, Php32.25 for hopia and Php30.00 for vinegar, the computed return on cash expense is Php25.52%, Php 25.10% and Php25.13% respectively.

Using deep yellow and violet fleshed sweetpotato contains higher amount of vitamin A (164.98 & 146.65 ugRE), energy (325.17 and 321.34 kcal), carbohydrate (33.95 and 33.45 g) and calcium, (587.17 and 583.84 mg) per 375 ml of yoghurt than the plain yoghurt with lower nutrient content (Table 11).

Sweetpotato Hopia has a higher amount of vitamin A (43 & 33.84 ug RE) and calcium (59.05 & 57.38 mg) and with lower fat content (6.96 g), which is healthier compared with the commercial ‘hopyang baboy’ (Table 12).

This result indicates that yoghurt and hopia with sweetpotato either yellow, orange and violet fleshed can give higher vitamin A and calcium.

For the sales turnover, a 15.74% (48 bottles) increase in the number of bottles sold for yoghurt as well as a 32.67% (33 bottles) increases for vinegar was observed for the first 6 months of 2013.

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