PREPARATION AND STORAGE QUALITIES OF FORTIFIED NATA DE COCO

By ARACELI L. DOLENDO and PACITA L. MANIQUIS
National Institute of Science and Technology, Manila

TWO TEXT FIGURES

INTRODUCTION

Nata de coco is a mass of gelatinous substance which forms on the surface of coconut water medium produced by some bacteria of which opinions of several workers (1, 11, 15) vary as to its identity.

Valuable data on coconut water are available. Peters(17) isolated and identified the B-group vitamins present in coconut water. The corresponding amounts of these vitamins in each cubic centimeter of coconut water are: nicotinic acid, 0.01 microgram; biotin, 0.02 microgram; panthothenic acid, 0.52 microgram; riboflavin, 0.01 microgram; folic acid, 0.003 microgram. Miller(12) found coconut water to have the following composition: protein, 0.23 per cent; carbohydrates, 3.68 per cent; fat, 3.56 per cent; calcium, 0.03 per cent; and phosphorus, 0.01 per cent. Intengan, et al.(7) reported the composition of coconut water as follows: protein, traces; fat, 0.2 per cent; carbohydrates, 5.1 per cent; ash, 0.3 per cent; calcium, 16 per cent; phosphorus, 6 per cent; iron, 0.2 per cent; and traces of thiamine, riboflavin, niacin, and absorbic acid. Caray(5) identified and isolated sucrose, dextrose and fructose as sugars present in coconut water. It is probable that the presence of these nutrients stimulates the growth of the organism that produces *nata* in coconut water.

Analysis of nata de coco cooked in syrup, also known as nata de coco preserve,(14) shows that it contains water, 67.7 per cent; protein, nil; fat, 0.2 per cent; calcium, 12 mg per cent; iron, 5 mg per cent; phosphorus, 2 mg per cent; thiamine, traces, riboflavin, 0.01 microgram per cent.

The above review shows that only a few of the nutritive constituents of coconut water are transmitted to the nata. Nata de coco preserve may therefore be considered as a food without

nutritive value, although it ranks as a food of major importance when "consumers' appetite" is concerned.

Nata de coco preserve is considered a delicacy among Filipinos. The cost involved in its preparation as well as the price of the commercial processed product are within the reach of the major segment of the population.

Fortification of nata de coco preserve with some vitamins and essential minerals will make this product more beneficial to consumers as its nutritive value will be enhanced and its flavor, texture, and color improved. It will also help bolster the vitamin and mineral intakes of our people which will in a way alleviate the malnutrition problems of the country. It will also appeal to nutrition-conscious consumers who are appreciative of the widening variety of foods which provide them with better nutrition.

This study was conducted (*a*) to study the possibility of increasing the nutritional quality of nata de coco preserve without impairing the degree of preference of the consumer for this food and (*b*) to determine the effect of storage on the nutrient composition in the liquid and solid phases and acceptability of the fortified nata de coco.

MATERIALS AND METHODS

The method used is a modification of the traditional method of processing nata de coco preserve. The traditional method for processing is briefly described below.

The newly harvested nata de coco is cleaned and sliced to a desired size. It is then boiled with constant changing of water until the product is free from acid flavor. The acid-free product is drained and boiled with syrup. The sugar impregnated nata is bottled, exhausted, sterilized, and packed.

The steps modified in the traditional method are: leaching of the nata, syruping, packaging, and an additional step of fortification.

Leaching of raw nata.—Boiling of the raw nata with water is the method used in leaching the acids accumulated in the nata during its formation by the microorganism. According to our findings, the conventional method of continuous boiling causes the browning of the product. This method was modified in this study. In this modified procedure, the clean and sliced product was boiled for five minutes, immediately washed with water and soaked in tap water overnight. This

step was repeated daily until the product was free from acid flavor.

Syruping.—It was observed that the concentration of the syrup of the preserved nata decreases rapidly until the syrup becomes watery on storage. It is therefore necessary to equilibrate the syrup of the nata before subjecting to fortification. In this way, any change in sugar concentration after fortification will not be caused by diffusion of sugar to the nata but rather it may just be attributed to the effect of the added nutrients.

The modified method of syruping was to mix the nata de coco with extra heavy syrup (2:1, sugar: water) and boiled for five minutes. The resulting mixture gives a syrup with 76-per cent soluble solids. The boiled product in syrup was allowed to cool at room temperature and kept in a refrigerator to prevent the onset of any fermentation. This step was repeated daily until the syrup concentration of 45° to 50° Brix was attained for two consecutive readings at 12 hours interval. Whenever the sugar concentration fell below the working standard of 45° to 50° Brix before the concentration got stabilized, sugar was added until the concentration was within the working standard.

Fortfication.—The sugar-impregnated nata de coco was drained of its syrup. The drained nata was weiged. A newly prepared syrup (1:1 sugar: water) was added to the syrup from the drained nata until its weight was equal to the drained nata. The syrup was boiled in a stainless steel container until a clear syrup was obtained. The impurities which coagulated were removed by skimming. The syrup was further clarified by filtration through a cheese cloth and was then fortified with the vitamins, niacin, thiamine, riboflavin, ascorbic acid, and minerals calcium and phosphorus.

The calculated amounts of nutrients based on a well-blended flavor as evaluated by the flavor profile method of Cairncross(4) were added to the syrup. Calcium di-phosphate was added to the boiling syrup, stirred until dissolved and cooled to a temperature of 50° to 60° C. At this temperature of the syrup, all the vitamins, in the order of their stability to the existing conditions, were added as follows: niacin, thiamine, riboflavin, and ascorbic acid. The container was covered with opening just enough for the stainless steel ladle to move around. This will prevent the entrance of light and incorporation of too much air

in the syrup during stirring. Drops of food flavoring were added. The flavoring used in this study was *kalamansi* (*Citrus microcarpa* Bunge) oil.[1]

Packaging.—The conventional way of bottling nata de coco preserve is the use of clear glass jars. In fortified nata de coco, these clear glass jars must be further wrapped to prevent absorption of light by the fortified product. In this study, the fortified nata de coco was bottled in a clear glass jar and wrapped in dark green cellophane. Dark colored cellophane was used so that the product is visible, otherwise ordinary Manila paper wrapping might serve the purpose. If amber glass jars or enameled cans are used, wrappings may not be necessary.

Storage studies.—Analysis of the fortified nata de coco: solid and liquid portions combined; liquid portion only, and drained nata only were conducted after processing to determine the per cent retention of the added nutrients.

All the bottled fortified nata de coco samples were divided into two lots. One lot was stored in a shelf at room temperature (30° C) and the other in a household refrigerator (4° C). At monthly intervals up to 11 months, random samples of four bottled fortified nata de coco were taken from each storage condition. In order to determine if the nata (solid portion) had absorbed the nutrients, two of the bottled nata de coco from each storage condition were drained thoroughly of its syrup. The solid and liquid portions were separately subjected to objective quality evaluation as pH of the syrup; soluble solids and chemical analysis for the added nutrients as thiamine, riboflavin, niacin, ascorbic acid, calcium, and phosphorus.

The rest of the bottled fortified nata de coco from the two storage conditions were used for acceptability test of the product.

The following methods were used for analysis:

pH: The pH of the syrup was read on a Beckman pH meter model No. G.

Soluble solids: Soluble solid content of the syrup was measured with a Zeiss-Opton hand refractometer. The results were reported as per cent soluble solids.

Chemical analysis: Thiamine was measured by the Hennessey and Cerecedo thiochrome method as reported by Munsell, et al.(13) Riboflavin was measured by the Hodson and Norris fluorometric method.(6) Niacin

[1]Kalamansi oil was supplied by Mrs. Luz V. Adeva of the Food Research Laboratory.

was measured by the U.S. Pharmacopoeia microbiological method.(16) Ascorbic acid was measured by the Bolin and Book modification of Roe and Oesterling colorimetric method.(3) Calcium was determined by Official and Tentative Methods of Analysis of the Association of Official Agricultural Chemists.(2) Phosphorus was determined by Lowry and Lopez modification of the Fiske and Subbarow method.(10)

Acceptability test.—Samples from each storage condition were evaluated by paired comparison,(9) by a taste panel of 26 persons. These panel tasters are members of the technical staff of the Food Research Laboratory, FNRC, NIST and have the ability to recognize off-flavor characteristics of the product. In conducting the acceptability test, each taster received a tray containing two samples of fortified product—one of which was stored under room temperature storage and the other from refrigerated storage. Each sample was put in an amber cup container. Amber cups were used to mask all the other attributes of the product except flavor and aroma. Flavor and aroma were the sensations evaluated by the panel tasters as the product aged in each storage condition. The amber cups were coded with a three-digit number. Attached to each tray was a paper containing instructions as follows:

Name ..... Date ..... Time .....
Taste each sample and indicate which one you prefer.
You must make a choice, even if only a guess.

The responses were tested statistically using the "t" test.

RESULTS AND DISCUSSION

Retention of nutrients.—Table 1 shows the nutrient composition of the fortified nata preserve before and after processing. Thiamine being heat-labile and riboflavin which is light-labile, were the vitamins most affected by the processing conditions, showing 89- and 97-per cent retention, respectively. The investigators could not attribute the loss of thiamine to the temperature of the syrup because thiamine is considered stable up to one hour at 100° C and at pH 3.5. We may attribute the loss of thiamine to the pH of the syrup which was 6.25 at the time it was added and did not decrease until after processing. Niacin was very stable under conditions encountered in processing so that its loss was negligible, giving 94-per cent retention. Ascorbic acid, being the last nutrient added was therefore least exposed to oxygen in the air. Furthermore, the temperature of the syrup was at its minimum when it was added. Hence a 96-per cent retention was attained.

TABLE 1.—*Per cent retention of nutrients after processing fortified nata de coco.*

Nutrients	Unfortified nata de coco	Fortified nata de coco		Retention
		a Amount dded before processing	Amount soon after processing	
	mg 100 g	*mg 100 g*	*mg 100 g*	*Per cent*
Niacin	nil	7.522	7.070	94
Thiamine	traces	0.6443	0.5748	89
Riboflavin	0.0100	0.3682	0.3298	87
Ascorbic acid	nil	27.61	26.62	96
Calcium	12	62.86	67.68	89
Phosphorus	2	95.14	71.00	73

Calcium and phosphorus were added in the form of calcium diphosphate, a very stable substance and soluble in water. Since the solvent was a heavy syrup in this process, its solubility was lower. This low retention of calcium (89 per cent) and phosphorus (73 per cent) could have been caused by some undissolved calcium di-phosphate that may have settled at the bottom of the mixer.

The pH of the samples (Fig. 1) stored under the two storage conditions (refrigerated and under room temperature) was always on the acid side up to the end of the experimental study. The acidic reactions observed might be attributed to the fact that the aqueous solution of the nutrients added were acid.

After the first month storage, the pH of samples stored at refrigerated and at room temperature conditions were almost steady at pH 4.5 with sudden lowering after the fourth month storage. This sudden change could be due to weather condition (typhoon season) with interrupted electricity so that most of the time, both storage studies were subjected to the same condition from the third to the fourth months. After the seventh month up to the end of the study the pH remained stable at pH 3.5 in the two storage conditions. The slight increase of the pH to 4.1 on the eleventh month on the sample at room temperature storage might be caused by the varied room temperature (28° to 35° C) between the tenth and eleventh month storage. The maintenance of a low pH during storage was favorable to a high retention of vitamins.(8)

Distribution of nutrients in the solid and liquid phase.—The customary way of eating nata preserve is to eat the solid portion with little or no syrup at all. The nutrient content of the product at the time they are eaten is the most important

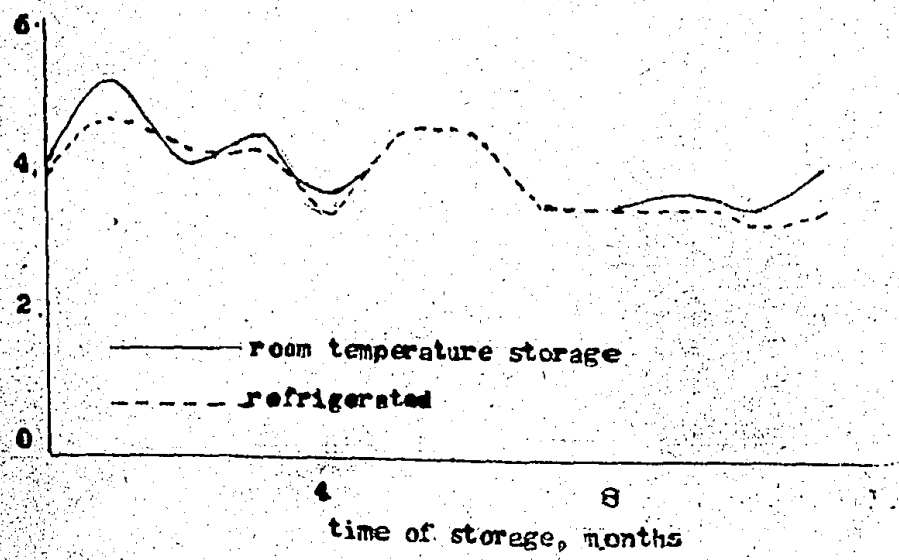

FIG. 1. Changes in pH of the fortified nata de coco stored under two storage conditions (refrigerated and under room temperature).

consideration from the standpoint of consumers' health. Since the fortified nata de coco is syrup-packed and only the syrup was fortified, the solid and liquid phase distribution of the nutrients is a very important consideration to verify. All the nutrients added were water-soluble so that a good picture of such distribution could be obtained by determining the nutrient retention during storage in the liquid and solid phases independently.

Tables 2 and 3 show the distribution of nutrients in the solid and liquid phases during the eleventh-month storage. After processing (0 time), the added nutrients were almost equally distributed between the solid and liquid phases, except for niacin and riboflavin. From the first month storage up to the end of the experimental studies, the nutrient distribution in the two phases was no longer the same as the initial distribution on both storage conditions. There was negligible decrease of nutrient levels in the samples stored at refrigerated condition. This may be due to the controlled temperature (4° C) storage. Also, the low pH would explain the negligible loss of some vitamins since vitamins are more stable under this condition.(8) The riboflavin and ascorbic acid levels in the solid and liquid phase decreased in the samples stored at room temperature. This may be due to the oxidizing property of the riboflavin. The small percentage decreases and increases of

TABLE 2.—*Distribution of nutrients in the liquid and solid phase of fortified nata de coco during storage at refrigerated temperature (4°C) for 11 months.*

(Time of storage, months.)

Nutrients mg/100 gm	0	1	2	3	4	5	6	7	8	9	10	11
Thiamine:												
Solid phase	0.47	0.44	0.48	0.56	0.53	0.48	0.44	0.52	0.53	0.52	0.54	0.56
Liquid phase	0.52	0.42	0.49	0.45	0.42	0.43	0.52	0.50	0.46	0.54	0.51	0.54
Riboflavin:												
Solid phase	0.41	0.34	0.34	0.33	0.24	0.23	0.17	0.22	0.24	0.29	0.29	0.26
Liquid phase	0.20	0.29	0.29	0.32	0.31	0.21	0.16	0.13	0.14	0.19	0.19	0.24
Niacin:												
Solid phase	4.1	5.0	4.6	5.0	4.7	5.4	4.6	5.6	5.1	5.5	4.5	5.6
Liquid phase	9.1	5.8	4.9	5.1	5.7	5.5	5.5	5.5	5.2	5.7	4.6	5.0
Ascorbic acid:												
Solid phase	26.0	17.0	26.0	22.0	22.0	25.0	21.0	20.0	22.0	20.0	20.0	24.0
Liquid phase	30.0	25.0	22.0	21.0	28.0	22.0	24.0	18.0	21.0	23.0	24.0	25.0
Calcium:												
Solid phase	47.0	63.0	49.0	84.0	77.0	32.0	34.0	42.0	47.0	44.0	59.0	51.0
Liquid phase	43.0	31.0	95.0	61.0	71.0	38.0	26.0	37.0	33.0	36.0	49.0	50.0
Phosphorus:												
Solid phase	33.0	33.0	33.0	41.0	28.0	31.0	38.0	28.0	34.0	30.0	28.0	37.0
Liquid phase	34.0	26.0	28.0	45.0	20.0	35.0	30.0	26.0	29.0	28.0	30.0	34.0
pH	3.8	4.6	4.2	4.2	3.4	4.5	4.5	3.5	3.5	3.5	3.3	3.5
Soluble solids (°Brix)	49.0	49.0	49.0	49.0	49.0	48.5	48.0	48.5	49.5	48.0	48.0	47.5

TABLE 3—*Nutrient contents of fortified nata de coco during storage at room temperature (30°C) for 11 months.*

(Time of Storage, months.)

Nutrients mg/100 gm	0	1	2	3	4	5	6	7	8	9	10	11
Thiamine:												
Solid phase	0.47	0.44	0.46	0.41	0.33	0.41	0.44	0.51	0.51	0.50	0.44	0.49
Liquid phase	0.52	0.43	0.48	0.44	0.44	0.38	0.48	0.49	0.49	0.51	0.45	0.48
Riboflavin:												
Solid phase	0.41	0.35	0.34	0.25	0.29	0.21	0.22	0.18	0.21	0.18	0.18	0.16
Liquid phase	0.20	0.29	0.33	0.33	0.31	0.20	0.17	0.15	0.16	0.19	0.16	0.19
Niacin:												
Solid phase	4.1	5.0	7.1	4.9	4.7	5.7	3.7	5.9	4.7	5.3	4.8	6.5
Liquid phase	9.1	7.1	4.6	5.2	6.2	5.5	5.0	5.5	5.2	5.4	4.7	4.7
Ascorbic acid:												
Solid phase	26.0	20.0	27.0	22.0	20.0	13.0	16.0	14.0	15.0	18.0	14.0	14.0
Liquid phase	30.0	22.0	27.0	20.0	23.0	20.0	18.0	14.0	17.0	18.0	10.0	10.0
Calcium:												
Solid phase	47.0	63.0	45.0	87.0	66.0	28.0	40.0	45.0	45.0	46.0	58.0	53.0
Liquid phase	43.0	32.0	94.0	63.0	60.0	41.0	30.0	33.0	38.0	37.0	47.0	39.0
Phosphorus:												
Solid phase	38.0	43.0	31.0	43.0	24.0	27.0	35.0	25.0	35.0	33.0	30.0	36.0
Liquid phase	34.0	26.0	29.0	46.0	20.0	34.0	27.0	30.0	25.0	26.0	24.0	32.0
pH	3.8	5.1	4.0	4.4	3.6	4.5	4.5	3.5	3.5	3.7	3.5	4.1
Soluble solids (°Brix)	49.0	49.0	49.0	49.0	49.0	48.5	48.0	49.0	49.0	48.0	48.5	45.0

nutrients in both phases under the two storage conditions could not be explained since the total nutrient content (solid and liquid) of the whole *nata* preserve was not determined during its monthly analysis.

The movement of the nutrients in the two phases followed the same trend. That is, there was an increase in concentration in the liquid or solid phase until a time when the concentration in the two phases was the same. After this point, the concentration reversed in the two phases. This shows that the nutrients migrate from the liquid to solid and back in a continuous cycle with different migration velocities for each nutrient.

In terms of our observations, we may describe nata as the solid phase which acts as an adsorbent and the added nutrients as the adsorbable substances (adsorptives). When the solution of nutrients was brought into contact with an adsorbent (solid phase), molecules of the adsorptive pass out of the solution into the interfacial region of the adsorbent and were retained for a longer or shorter time depending on the strength of adsorption on each nutrient. As the concentration of each nutrient builds up in the interface of the solid phase, the solution is depleted of the nutrients. But by reverse process, the escape of nutrients from interface into solution is also occuring and eventually an equilibrium state was reached when the solution and solid phases had equal concentration of nutrients. The state of equilibrium was only for a short time and desorption or adsorption of nutrients starts again.

In the two storage conditions, calcium had a very irregular movement in the two phases up to the fifth month before it became more or less stable. The movement of phosphorus in the two phases was more uniform as compared to calcium. Except for the bahavior of riboflavin in samples stored in the refrigerator, all the nutrients in the two phases might be considered stable after the seventh month.

The soluble solids (Tables 2 and 3) in the syrup which may be considered as its sugar concentration remains constant up to the end of the eleventh month storage. This shows that the sugar concentration was well stabilized before fortification. The movement of nutrients in the two phases may be considered independent of the stable sugar concentration.

Acceptability test.—Results of the acceptability tests were analyzed statistically using the "t" test. These are shown in

Table 4. The absolute value of "t" was 1.03 which is less than the t-value of 2.086 at 95-per cent confidence. Hence, it can be concluded that there was no significant difference in the acceptability of the product stored at room temperature or under refrigerated condition.

TABLE 4.—*Acceptability test of the fortified nata de coco under two storage conditions.*

Time in months	Room temperature storage (*Number of tasters accepting the product*)	Refrigerated temperature storage (*Number of tasters accepting the product*)
1	19	7
2	18	8
3	16	10
4	14	12
5	14	12
6	20	6
7	17	9
8	11	15
9	11	15
10	6	20
11	8	18

Statistical analysis by "t" test

t=1.03 for d.f.=20 t.05=2.086 ∴ it is not significant

Having obtained no significant results by using the t-test, the investigators tried another method—a graphical analysis of the taste panel responses. The three-month moving average of the number of tasters preferring fortified nata stored under each condition (i.e., stored at room temperature and refrigerated temperature) were plotted against storage time (Fig. 2).

It may be observed from the graph that there is decidedly a stronger preference among the panel of tasters for fortified nata stored at room temperature up to the seventh month. Starting the seventh month, the preference for that stored at room temperature showed a rapid decline, while that stored by refrigerated temperature increased. On the ninth month, there was equal preference for the fortified nata stored under both conditions. Thereafter preference for that stored at room temperature continuously declined while that stored at refrigerated temperature continuously increased. This definite reversal of preference among panel tasters for fortified nata stored at refrigerated temperature may be attributed to the stability of nutrient levels in the liquid and solid phases as was mentioned earlier. The stability of the nutrients levels may have influenced the formation of a complete blend of nutrients resulting in a more desirable flavor and aroma.

Table 4. The absolute value of "t" was 1.03 which is less than the t-value of 2.086 at 95-per cent confidence. Hence, it can be concluded that there was no significant difference in the acceptability of the product stored at room temperature or under refrigerated condition.

TABLE 4.—*Acceptability test of the fortified nata de coco under two storage conditions.*

Time in months	Room temperature storage	Refrigerated temperature storage
	(Number of tasters accepting the product)	*(Number of tasters accepting the product)*
1	19	7
2	18	8
3	16	10
4	14	12
5	14	12
6	20	6
7	17	9
8	11	15
9	11	15
10	6	20
11	8	18

Statistical analysis by "t" test

t=1.03 for d.f.=20 t.05=2.086 ∴ it is not significant

Having obtained no significant results by using the t-test, the investigators tried another method—a graphical analysis of the taste panel responses. The three-month moving average of the number of tasters preferring fortified nata stored under each condition (i.e., stored at room temperature and refrigerated temperature) were plotted against storage time (Fig. 2).

It may be observed from the graph that there is decidedly a stronger preference among the panel of tasters for fortified nata stored at room temperature up to the seventh month. Starting the seventh month, the preference for that stored at room temperature showed a rapid decline, while that stored by refrigerated temperature increased. On the ninth month, there was equal preference for the fortified nata stored under both conditions. Thereafter preference for that stored at room temperature continuously declined while that stored at refrigerated temperature continuously increased. This definite reversal of preference among panel tasters for fortified nata stored at refrigerated temperature may be attributed to the stability of nutrient levels in the liquid and solid phases as was mentioned earlier. The stability of the nutrients levels may have influenced the formation of a complete blend of nutrients resulting in a more desirable flavor and aroma.

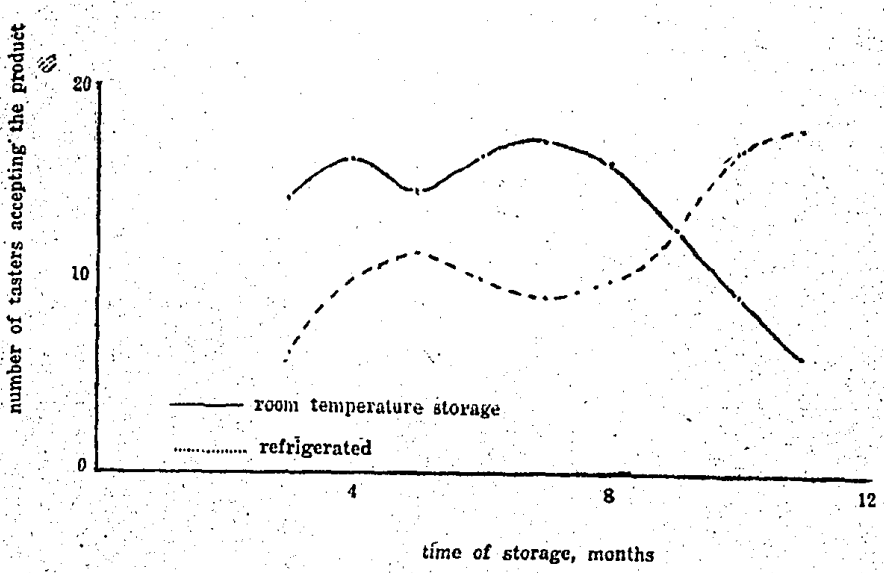

FIG. 2. Graphical analysis of the taste panel responses on fortified nata de coco stored under two storage conditions (refrigerated and under room temperature).

SUMMARY AND CONCLUSION

A newly harvested nata de coco was cleaned, deacidified and impregnated with sugar. The sugar-impregnated nata was drained of its syrup and the syrup was fortified with the following vitamins and minerals: niacin, 7.522 mg/100 gm; riboflavin, 0.3682 mg/100 gm; thiamine, 0.6443 mg/100 gm; ascorbic acid, 27.61 mg/100 gm; calcium, 62.86 mg/100 gm; and phosphorus 95.14 mg/100 gm. The sugar-impregnated nata with an equal weight of fortified syrup was bottled and processed. Thereafter a shelf-life study was conducted for 11 months on two storage conditions (refrigerated and room temperature storage.)

It was observed that after processing, niacin and ascorbic acid suffered negligible loss giving 94- and 96-per cent retention, respectively. The rest of the nutrients had the following per cent retention: thiamine, 89 per cent; riboflavin, 87 per cent; calcium, 89 per cent; and phosphorus, 73 per cent. The sugar concentration was constant during the experimental study. pH value was on the acid side and was steady at pH 3.5 after the seventh month in both storage conditions with a slight increase at the last month storage on the samples stored at room temperature. During storage the nutrients migrated

from liquid to solid and back in a continuous cycle with different migration velocities. The fortified nata was acceptable to the panel tasters.

It is possible to improve and increase the nutritional quality of nata de coco by fortifying it with vitamins and minerals without impairing the degree of preference of consumers for the food. The nutrients were more stable when samples were stored at constant low temperature (4° C). Nata and syrup both contain nutrients at any time during the 11 months shelf-life study under the two storage conditions. Fortified nata, whether stored at room temperature or refrigerated, were both acceptable to the panel tasters. However, there is a greater degree of preference for fortified nata stored at room temperature over that stored at refrigerated temperature up to the ninth month. Thereafter, fortified nata stored under refrigerated temperature became more preferred.

ACKNOWLEDGMENT

The authors wish to thank Dr. Conrado R. Pascual and Mrs. Isabel C. Abdon for their support in this research; to Mr. Jose G. Palad, Mrs. Emerina C. Eusebio, and Mrs. Erlinda P. Mandap for the monthly analysis of the vitamins and minerals; to the Food Microbiological Branch staff for supplying the raw nata de coco, to the senior technical staff of the Food Research Laboratory and the Technical Committee of the Food and Nutrition Research Center, National Institute of Science and Technology who gave valuable suggestions in the preparation of the manuscript.

REFERENCES

1. ALABAN, C.A. Studies on the optimum conditions for nata de coco bacterium or nata formation in coconut water. Phil. Journ. Agric. (9) 45 (1962) 490–516.
2. Association of Official Agricultural Chemist. Official and tentative method of analysis. 7th ed. Washington, D.C. The Association (1950) 910 pp.
3. BOLIN, D.W., and L. BOOK. Oxidation of ascorbic acid to dehydroascorbic acid. Science 106 (1947) 451.
4. CAIRNCROSS, S.E., and L.B. SJOSTROM. Flavor profile—A new approach to flavor problems. Food Tech. (8) 4 (1950) 308-311.
5. CARAY, M.E. Isolation and identification of some sugars in copra meal and coconut water. Phil. Journ. Agric. (6) 13 (1924) 229–253.

6. HODSON, A.Z., and L.C. NORRIS. A fluorometric method for determining the riboflavin content of foodstuffs. Jour. Biol. Chem. 131 (1939) 621–630.

7. INTENGAN, C.LL., I.C. ABDON, L.G. ALEJO, and J.G. PALAD. Food Composition Table Recommended for use in the Philippines, Food and Nutrition Research Center, NIST and NSDB. Handbook 1 (3rd Revision) 1964.

8. JOSLYN, M.A., and J.Z. HEID. Vitamins as ingredients in food processing. Food Proc. Oper. 2 (1963) 192–217. The Avi Publishing Company, Inc. Westport, Connecticut.

9. KRAMER, AMIHUD, and B.A. TWIGG. Taste testing. Fundamentals of quality control for the food industry. Avi Pub. Co., Inc., Westport, Conn. (1962) 105–138.

10. LOWRY, O.H., and J.A. LOPEZ. The determination of inorganic phosphates in the presence of labile phosphate esters. Journ. Biol. Chem. 162 (1946) 421–428.

11. MENDOZA, J.M. Philippine Foods, Their Processing and Manufacture. Printed in the Philippines, 1961.

12. MILLER, C.D. Food values of bread-fruit, tea leaves, coconut and sugar cane. Bernice P. Bishop Mus. Bull. 64 (1929) 3–23.

13. MUNSELL, H.E., L.C. WILLIAMS, L.P. GUILD, C.G. TROESCHER, G. NIGHTINGALE, and R.S. HARRIS. Composition of food plants of Central America. I. Honduras. Food Res. 14 (1949) 44–164.

14. PALAD, J.G., I.C. ABDON, A.V. LONTOC, L.B. DIMAUNAHAN, E.C. EUSEBIO, and N. SANTIAGO. Nutritive value of some foodstuffs processed in the Philippines. Philip. Jour. Sci. 93 (1964) 355–384.

15. PALO, M.A., and M.M. LAPUZ. On the gum-forming streptococcus with studies on the optimum condition for the synthesis of the gum and its products in coconut water. Philip. Jour. Sci. 83 (1954) 327–353.

16. Pharmacopoeia of the United States. 14th ed. and 1st U.S.P. XIV suppl. Philadelphia, Mack Publishing Company (1950) 1+122 pp.

17. PETERS, F.E. The coconut in human diet. Food Nutr. Notes Rev. 8 (1951) 92–96.