ISSN 1682-296X (Print)
ISSN 1682-2978 (Online)

Bio Technology

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Biotechnology 4 (2): 121-125, 2005
ISSN 1682-296X

Development of Shelf-stable Ready-to-serve Green Coconut Water

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Abstract: The study report was on processing of fresh coconut water, its storage stability and overall acceptability. Coconut water collected from sound and green coconut was filtered through a filtering machine, pasteurized at 85°C for 10 min and cooled. The effect of citric acid, $K_2S_2O_2$, β-carotene, ascorbic acid and green colour were evaluated. The coconut water was filled into metal cans and glass bottles to assess the packaging effect. The change in colour, flavour, TSS, acidity, gas formation and fungal growth were observed while the samples were stored at room temperature (27 to 35°C) and a refrigerated temperature (4 to 6°C). The observation was made at an interval of 4 months up to 12 months. The colour and flavour of the processed green coconut water remained unchanged throughout the storage period. The addition of acid and preservatives improved transparency. No gas formation was observed in the canned and bottled water throughout the stored period. The acceptability of pasteurized water without addition of citric acid was highly satisfactory. The canned and bottled coconut water was found shelf-stable up to 12 months of storage at refrigerator temperature and 10 months of storage at room temperature. The results of sensory evaluation and shelf life of the processed green coconut water indicated that the fresh green coconut water could be bottled and canned successfully for consumption round the year.

Key words: Green coconut water, pasteurization, shelf life, sensory evaluation, β-carotene

INTRODUCTION

Coconut (*Cocos nucifera*) is one of the oldest fruits in the world and is confined to seacoast in the humid tropics. It is an important plantation crop of Bangladesh. The climatic condition of Bangladesh is suitable for the cultivation of coconut. Good quality of coconut is grown in the southern part of the country, especially in the greater Noakhali (10490 mt), Barisal, Jessore (17860 mt) and Khulna (11835 MT) Districts[1]. Green coconut water is the liquid endosperm that fills the central cavity enclosed by a solid endosperm protected by the hard cell and husk. Tender coconut water is a delicious and nutritious drink. In its natural state, it is sterile and is used as an oral rehydration medium for children suffering from gastro-enteristis[2]. Coconut water is also reported to contain substances capable of inducing rapid proliferation of plant tissue culture medium. Vinegar and *Nata decoco,* a fermented drink popular in the Philippines, are also prepared using coconut water as base. At its tender stage, a large nut may contain about 600 mL water with 30 g sugar and 2 g potassium. The water from green coconut is a refreshing drink during hot days.

Study of green coconut water and ready to serve coconut product has received much attention to the researchers throughout the world especially in physico-chemical properties, which are being studied all over the world. No sufficient information are available on processing, preservation and storage of fresh coconut under Bangladesh condition. In Bangladesh, huge quantity of coconut is grown in the southern part but the utility of green coconut is limited due to costly transport. If proper technology is developed to preserve coconut water in bottle or can, it will lead to easy transport and easy serve. Finally, it will lead to have higher production encouraging the grower and processors.

With the above views in consideration, the study was undertaken to develop process for preservation of fresh coconut water; to analyze the proximate composition of the fresh and processed coconut water; sensory evaluation of the processed coconut water and to study the storage stability of processed coconut water.

MATERIALS AND METHODS

The study was conducted in the Laboratory of the Department of Food Technology and Rural Industries and

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Table 1: Sample specification of processed green coconut water

	Sample specification					
Sample code	Pasteurization	Acidity	Vitamin ©	Carotene	KMS ($K_2S_2O_2$)	Colour
A	-	0.08		-	500 mg kg^{-1}	-
B	+	0.08	-	-	600 mg kg^{-1}	-
C	+	0.25 (addition of citric acid)	-	-	500 mg kg^{-1}	-
D	+	0.08	-	1.8 mg kg^{-1}	500 mg kg^{-1}	-
E	+	0.08	-		-	-
F	+	0.08	-		500 mg kg^{-1}	-
G	+	0.08	2 mg kg^{-1}	-	500 mg kg^{-1}	-
H	+	0.08	-	-	500 mg kg^{-1}	1 mg kg^{-1}

'+' Sign indicates positive activity, '-' Sign indicates on activity or addition

Department of Biochemistry, Bangladesh Agricultural University (BAU) Mymensingh during the period of July 2002 to October 2003. The green coconut was collected from local markets of Bangladesh Agricultural University, Mymensingh. With the help of sharp knife, coconut water was collected from green coconut.

Processing of green coconut water: Coconut water was collected from freshly harvested coconut and filtered. The filtered water was pasteurized at 85 °C for 10 min and then cooled. Eight samples were pre-treated as shown in Table 1. Potassium metabisulfite ($K_2S_2O_2$) and citric acid was used as preservative in different concentrations. Then the flavor, color, vitamins and β-Carotene were fortified as per requirement of human body. Then the samples were filled in to can and bottle keeping about 6 mm headspace. The can was exhausted in boiling water for 20 min and immediately sealed in a double seaming machine. The bottles were also exhausted in boiling water for 20 min and immediately closed with PP caps and/or crown caps. The cans were sterilized at 121°C for 30 min in an autoclave and bottles were at 100°C for 15 min. The heat-processed bottles and cans were immediately cooled under running water to 40°C. They were than Labeled, stored at ambient temperature and refrigerated temperature (4 to 10°C) for storage study.

Proximate analysis of green and processed coconut water: The strained green coconut water and the processed coconut water were analyzed for moisture, ash, vitamin-C, β-carotene, Total Soluble Solid (TSS), pH, titrable acidity, reducing sugar, non-reducing sugar and total sugar content. Acidity was estimated with standard NaOH using phenolphthalein as indicator. Vacuum oven drying method[3] was used for moisture determination and AOAC[4] method was used for determination of β-Carotene and ash. A Refractometer was used for determination of total soluble solid of the water. The ascorbic acid was determined by Rangana[5].

Sensory evaluation: A panel of 10 judges according to ISI specification and BSTI standard methods tasted green coconut water. All judges consisting the panel were conversant with the factors governing the quality of the products. The products were served to each judge who independently examined the characteristics a) colour and texture b) flavour and taste and © absence of defects. The uniformity of judgment among the judges was ascertained by adding up the scores given by them for individual characteristics. The relative importance of each factor was expressed numerically and recorded his/her observation in the score sheet. The average score of each factor with overall average for each product was then calculated. The score was arranged on a numerical scale of 100 and acceptability was determined from predetermined acceptability classes as score 91 and above is excellent products, score 86-90 is good products, score 81-85 is fair products and score 80 and below is not acceptable products.

Storage study: The samples of processed coconut water were stored at room temperature and refrigerated temperature (4 to 10°C). The acidity, colour, flavour, turbidity and microbial load were observed at an interval of one up to two months and then at an interval of two months.

RESULTS AND DISCUSSION

Chemical composition of green coconut water: It is shown from Table 2 that fresh coconut water is carotene free and the percentage of acidity is very low (0.08%). Biancardini and Tastadi[6] reported that the percentage of moisture, ash, total sugar, pH and ascorbic acid content of fresh coconut water were 95.3, 0.5, 3.2, 5.1 and 1 mg per 100 g of coconut water respectively. The percentage of moisture, ash and pH obtained from the analysis was much closed with the Biancardini and Tastadi[6] findings.

Chemical composition of processed green coconut water: The 8 samples of processed coconut water was analyzed

Table 2: Chemical analysis of green coconut water

Sample	Moisture (%)	Ash (%)	Acidity (%)	TS (%)	TSS (%)	Reducing sugar (%)	Non-reducing sugar (%)	Ascorbic acid mg/1000 mg	Carotene (µg/1000 g)
Green coconut water	95.5	0.6	0.08	4.5	4.0	3.2	0.6	2	0

Table 3: Chemical composition of processed green coconut water

Sample code	Moisture (%)	TS (%)	TSS (%)	Red. sugar (%)	Non-red. sugar (%)	Acidity (%)	Ascor. acid (mg/1000 g)	β-Caro. (mg/1000 g)
A	95.5	4.5	4	3.2	0.6	0.149	2.00	-
B	95.5	4.5	4	3.2	0.6	0.149	0.50	-
C	95.5	4.5	4	3.2	0.6	0.249	1.50	-
D	95.5	4.5	4	3.2	0.6	0.149	0.90	1.8
E	95.5	4.5	4	3.2	0.6	0.149	0.90	-
F	95.5	4.5	4	3.2	0.6	0.249	0.90	1.5
G	95.5	4.5	4	3.2	0.6	0.399	2.00	-
H	95.5	4.5	4	3.2	0.6	0.149	0.55	-

Table 4: Score awarded by the judges for canned green coconut water

	Average score				
Products	Colour and texture (25)	Taste and flavour (50)	Absence of defects (25)	Total score (100)	Remarks
Sample A	21.00	45.00	21.00	87.00	Good
Sample B	24.00	47.00	24.00	95.00	Excellent
Sample C	22.00	44.00	24.00	90.00	Good
Sample D	24.00	45.00	22.00	91.00	Good
Sample E	24.00	46.00	24.00	94.00	Good
Sample F	23.00	42.00	23.00	88.00	Good
Sample G	22.00	44.00	21.00	87.00	Good
Sample H	24.00	43.00	23.00	90.00	Good

Table 5: Score awarded by the judges for bottled green coconut water

	Average score				
Products	Colour and texture (25)	Taste and flavour (50)	Absence of defects (25)	Total score (100)	Remarks
Sample A	20.00	43.00	21.00	84.00	Good
Sample B	24.00	47.00	23.00	94.00	Excellent
Sample C	22.00	44.00	23.00	89.00	Good
Sample D	24.00	45.00	21.00	90.00	Good
Sample E	24.00	45.00	24.00	93.00	Good
Sample F	23.00	42.00	23.00	88.00	Good
Sample G	22.00	43.00	21.00	86.00	Good
Sample H	23.00	43.00	23.00	89.00	Good

Values in parenthesis indicate total No. of products

for moisture, ash, vitamin-C, Total Soluble Solid (TSS), titrable acidity, reducing sugar, non reducing sugar, total sugar content and β-Carotene.

There was a variation in acidity in processed green coconut water. The contents of acidity were in the range of 0.149 to 0.399%. This difference is due to addition of citric acid and heat treatment (Table 3).

Sensory evaluation of canned and bottled coconut water: The processed green coconut water stored in canned and bottled were subjected to the sensory evaluation and the mean scores for colour, flavour, texture and overall acceptability of different samples are presented in Table 4 and 5.

From the results, it is evident that the quality of processed green coconut water (Canned) were equally acceptable and did not shown significance difference with bottled coconut were. There was no significant difference in overall acceptability among the samples C, H and G and those samples were statistically equally acceptable. Sample A had the least overall acceptable when compared with other. Regarding overall acceptability of processed green coconut water the samples B, E, D and F were the most preferred and significantly better when compared with other samples.

Storage studies of processed coconut water: Eight samples of processed green coconut water were stored at room temperature (25° to 35°C) and refrigerated temperature (4 to 10°C). The effect of storage time (0, 4, 8, 10 and 12 months) on physical properties such as colour, flavour and visual fungal growth (under magnifying mirror) and on chemical properties such as Total Soluble Solid (TSS), acidity were studied (Table 6 and 7). From the storage studies, it was concluded that the colour of all samples were in good condition up to 12 months of storage in both temperatures. The flavour of all samples except C and G were in good condition up to 4 months of storage but after that time fermentation began in sample A. Fungal growth was observed in sample A and G after

Table 6: Storage properties of green coconut water (Refrigeration temperature)

		Samples							
Parameters	Storage period	A	B	C	D	E	F	G	H
Acidity	0	0.08	0.08	0.25	0.08	0.08	0.08	0.08	0.8
	2	0.14	0.13	0.28	0.14	0.14	0.14	0.15	0.14
	4	0.15	0.14	0.28	0.14	0.14	0.14	0.15	0.14
	6	0.15	0.14	0.28	0.14	0.14	0.14	0.15	0.14
	8	0.17	0.14	0.35	0.15	0.14	0.14	0.16	0.14
	10	0.17	0.15	0.38	0.15	0.15	0.15	0.16	0.14
	12	0.18	0.15	0.39	0.16	0.15	0.15	0.17	0.15
TSS	0	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
	2	0.39	4.00	4.00	4.00	4.00	4.00	4.00	4.00
	4	0.39	4.00	4.00	4.00	4.00	4.00	4.00	4.00
	6	0.39	4.00	4.00	4.00	4.00	4.00	0.38	4.00
	8	0.39	4.00	4.00	4.00	4.00	4.00	0.38	4.00
	10	0.38	4.00	4.00	4.00	4.00	4.00	0.38	4.00
	12	0.38	4.00	4.00	4.00	4.00	4.00	0.38	4.00
Colour	0	Natural	Natural	Natural	Yellow	Natural	Yellow	Natural	Greenish
	2	Natural	Natural	Natural	Yellow	Natural	Yellow	Natural	Greenish
	4	Natural	Natural	Natural	Yellow	Natural	Yellow	Natural	Greenish
	6	Slight cloudy	Natural	Slight blackish	Yellow	Natural	Yellow	Slight cloudy	Greenish
	8	Cloudy	Natural	Blackish	Yellow	Natural	Yellow	Cloudy	Greenish
	10	Cloudy	Natural	Blackish	Yellow	Natural	Yellow	Cloudy	Greenish
	12	Cloudy	Natural	Blackish	Yellow	Natural	Yellow	Cloudy	Greenish
Taste and Flavour	0	Good	Good	Good	Good	Good	Good	Good	Good
	2	Good	Good	Good	Good	Good	Good	Good	Good
	4	NG	Good	Good	Good	Good	Good	NG	Good
	6	NG	Good	NG	Good	Good	Good	NG	Good
	8	NG	Good	NG	Good	Good	Good	NG	Good
	10	NG	Good	NG	Good	Good	Good	NG	Good
	12	NG	Good	NG	Good	Good	Good	NG	Good
Gas formation	0	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
	2	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
	4	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
	6	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
	8	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
	10	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
	12	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Fungal growth	0	NGO	NGO	NGO	NGO	NGO	NGO	NGO	NGO
	2	NGO	NGO	NGO	NGO	NGO	NGO	NGO	NGO
	4	GO	NGO	NGO	NGO	NGO	NGO	GO	NGO
	6	GO	NGO	NGO	NGO	NGO	NGO	GO	NGO
	8	GO	NGO	NGO	NGO	NGO	NGO	GO	NGO
	10	GO	NGO	NGO	NGO	NGO	NGO	GO	NGO
	12	GO	NGO	NGO	NGO	NGO	NGO	GO	NGO

Table 7: Storage properties of green coconut water (Room Temperature)

		Samples							
Parameters	Storage period	A	B	C	D	E	F	G	H
Acidity	0	0.08	0.08	0.25	0.08	0.08	0.08	0.080	0.8
	2	0.14	0.14	0.28	0.13	0.14	0.14	0.150	0.14
	4	0.14	0.14	0.28	0.13	0.14	0.14	0.150	0.14
	6	0.15	0.15	0.28	0.13	0.14	0.14	0.150	0.14
	8	0.17	0.15	0.35	0.14	0.14	0.14	0.160	0.14
	10	0.18	0.15	0.38	0.15	0.15	0.15	0.160	0.14
	12	0.20	0.16	0.39	0.16	0.15	0.16	0.190	0.16
TSS	0	4.00	4.00	4.00	4.00	4.00	4.00	4.000	4.00
	2	0.39	4.00	4.00	4.00	4.00	4.00	4.000	4.00
	4	0.39	4.00	4.00	4.00	4.00	4.00	4.000	4.00
	6	0.39	4.00	4.00	4.00	4.00	4.00	0.395	4.00
	8	0.38	4.00	4.00	4.00	4.00	4.00	0.390	4.00
	10	0.37	4.00	4.00	4.00	4.00	4.00	0.380	4.00
	12								
Colour	0	Natural	Natural	Natural	Yellow	Natural	Yellow	Natural	Greenish
	2	Natural	Natural	Natural	Yellow	Natural	Yellow	Natural	Greenish
	4	Natural	Natural	Natural	Yellow	Natural	Yellow	Natural	Greenish
	6	Slight cloudy	Natural	Slight blackish	Yellow	Natural	Yellow	Slight cloudy	Greenish
	8	Cloudy	Natural	Blackish	Yellow	Natural	Yellow	Cloudy	Greenish
	10	Cloudy	Natural	Blackish	Yellow	Natural	Yellow	Cloudy	Greenish
	12	Cloudy	Natural	Blackish	Yellow	Natural	Yellow	Cloudy	Greenish

Table 7: Continued

Parameters	Storage period	Samples A	B	C	D	E	F	G	H
Taste and Flavour	0	Good	Good	Good	Good	Good	Good	Good	Good
	2	Good	Good	Good	Good	Good	Good	Good	Good
	4	NG	Good	Good	Good	Good	Good	NG	Good
	6	NG	Good	NG	Good	Good	Good	NG	Good
	8	NG	Good	NG	Good	Good	Good	NG	Good
	10	NG	Good	NG	Good	Good	Good	NG	Good
	12	NG	Good	NG	Good	Good	Good	NG	Good
Gas formation	0	0	Nil	Nil	Nil	Nil	Nil	Nil	Nil
	2	2	Nil	Nil	Nil	Nil	Nil	Nil	Nil
	4	4	Nil	Nil	Nil	Nil	Nil	Nil	Nil
	6	6	Nil	Nil	Nil	Nil	Nil	Nil	Nil
	8	8	Nil	Nil	Nil	Nil	Nil	Nil	Nil
	10	10	Nil	Nil	Nil	Nil	Nil	Nil	Nil
	12	12	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Fungal growth	0	NGO	NGO	NGO	NGO	NGO	NGO	NGO	NGO
	2	NGO	NGO	NGO	NGO	NGO	NGO	NGO	NGO
	4	GO	NGO	NGO	NGO	NGO	NGO	GO	NGO
	6	GO	NGO	NGO	NGO	NGO	NGO	GO	NGO
	8	GO	NGO	NGO	NGO	NGO	NGO	GO	NGO
	10	GO	NGO	NGO	NGO	NGO	NGO	GO	NGO
	12	GO	NGO	NGO	NGO	NGO	NGO	GO	NGO

four months of storage, which were finally spoiled. Ash, Total Soluble Solid (TSS) and gas formation remained almost unchanged during the full period of storage.

The study of sensory evaluation and shelf life of the processed green coconut water indicates that the fresh green coconut water could be bottled and canned successfully for consumption round the year.

REFERENCES

1. BBS (Bangladesh Buren of Statistics), 1998. Statistical Year Book of Bangladesh. 1st Edn., pp: 184.
2. Jyalekshmy, A., C. Arumughan, C.S. Narayanan and A.G. Mathew, 1986. Changes in the chemical composition of coconut water during maturation. J. Food Sci. Technol., 23: 203-207.
3. Kramer, E., 1980. Technique for measurement of moisture content of foods. J. Food Technol., 34: 52-59.
4. Aoac, 1984. Official Methods of Analysis. 14th Edn. Association of Official Analytical Chemists, Washington, D.C., USA.
5. Ranganna, S., 1992. Hand Book of Analysis of Quality Control for Fruit and Vegetables Products. 2nd Ed. Tata Mcgraw-hill Plus. Co. Ltd. New Delhi., India.
6. Biancardini, A., H. Tastaldi and S. Paulo, 1965. Vitamin C content in Some Farm Fruits. Bangladesh J. Nutr., 3: 9-13.