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Full Length Research Paper

Quality estimation of cashew gum in the production of chocolate pebbles

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Due to the limited supply and high cost of gum Arabic, cashew gum (CG) was assessed as a quick coating agent in the production of chocolate pebbles, using gum from both young and mature cashew trees. Acute toxicity tests on rats did not reveal any abnormal changes attributable to ingestion of CG. Pebbles produced with CG samples were compared with those produced with gum Arabic. The ash contents of the three products ranged from 2.37 to 2.63% and the moisture content from 2.33 to 2.76% whilst the sugar concentration ranged from 26.05 to 29.66%. The microbial status of the three products conformed to specifications of the Cocoa Processing Company (CPC). Physico-chemical parameters determined showed significant differences among the three products ($p < 0.05$). Sensory analysis showed no significant difference among products in terms of flavour, hardness and smoothness. The overall acceptability of the products were similar and the mean scores were 7.4, 6.8 and 7.1 for pebbles produced with gum Arabic, that produced with cashew gum from young and mature trees respectively. On a 9-point hedonic scale, this range varies from "like moderately" to "like extremely". Pebbles produced with cashew gum compared favourably with that produced with gum Arabic.

Key words: Cashew gum, gum arabic, chocolate pebbles, acute toxicity.

INTRODUCTION

Gums consist of heterogeneous complex mixtures of closely related polysaccharides, which produce viscous solutions or dispersions when dissolved in hot or cold water (Belitz et al., 2004). They are best known as powerful thickeners but perform an extraordinary number of other functions essential to food quality. In recent years, gums have been recognized as healthy sources of fiber as well (Hundley, 2002). There are four different types of natural gums, which are plant/tree exudates, seed gums, microbial gums and seaweed gums (Glicksman, 1969).

Plant exudates are gums from various plant species obtained as a result of tree bark injury. They are normally collected as air-dried droplets (Fitwi, 2000). They have been found to have many industrial potentials. About one billion pounds of gum are consumed in the United States each year where the growth in demand exceeds 8% per year (FAO, 2002). In Ghana about 10 tonnes of gum is used annually by industries (Frimpong-Mensah, 2000).

Gum from the cashew tree (*Anacardium occidentale* L), which is a plant exudate, has physico-chemical and rheological properties similar to gum Arabic, which is obtained from *Acacia senegal* (Smith and Montgomery, 1959; Owusu et al., 2005)). Cashew gum is a complex polysaccharide of high molecular mass comprising 72 -73% galactose, 4.6 - 5% arabinose, 3.2 - 4% rhamnose, 11 - 14% glucose and 4.7 -6.3% glucuronic acid (Cunha et al., 2007). Gum Arabic serves as a coating agent and film-former in panned confections such as chocolate pebbles (TIC Gums, 2001). However, its high cost has led to the assessment of other tree gums such as CG in the production of chocolate pebbles.

MATERIALS AND METHODS

Materials used included milled CG samples, gum Arabic from the Forest Research Institute of Ghana, Kumasi and rats obtained from the Department of Pharmacy, KNUST. Chocolate liquid and powder were obtained from Cocoa Processing Company, Tema. Peanuts, icing sugar, cornstarch, titanium dioxide, bees wax, equipment, apparatus and reagents.

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Acute toxicity of CG

Thirty mature male rats divided into groups of five were used for the toxicity test. They were fed with food and hygienic water and their initial weights measured. Six doses of CG per kg body weight (b.w.) were selected and administered to the different groups of rats orally. A control group was given water. The doses were administered as follows: 3, 5, 10, 15, 20 and 30 g/kg b.w. The rats were then observed continuously for 14 days for changes in movement, appetite, water intake, salivation, diarrhea, and urination.

Microbial status of CG

Enumeration of total microbial growth

Serial dilutions of CG samples were made in Ringer's solution and allowed to stand for 15 min in a water bath at 40°C. Aliquots of 1 ml were surface spread on highly rich nutrient agar and incubated at 35°C for 48 h.

Enumeration of yeasts and moulds

Serial dilutions of CG samples were made in Ringer's solution and allowed to stand for 15 min in a water bath at 40°C. Aliquots of 1 ml were surface spread on malt extract agar and incubated at 27°C for 120 h.

Determination of coliforms

Serial dilutions of CG samples were made in Ringer's solution and allowed to stand for 15 min in a water bath at 40°C. Aliquots of 1 ml were put into test tubes containing 9 ml lauryl sulphate broth and inverted tubes. Malt extract agar was then added to the contents of the test tubes and incubated at 35° C for 24 h. Absence of air bubbles in the inverted tubes indicates the absence of coliforms.

Preparation of beeswax, sugar syrup, starch and gum solutions

Gums from both mature and young cashew trees were sterilized in a Gallenkamp autoclave (UK) at 121°C for 15 min and used in the preparation of aqueous gum solutions in a water: gum ratio of 60:40 w/v (66.7%). An aqueous solution of gum Arabic, which is the conventional gum used for pebbles production (TIC Gums, 2001) in a water:gum ratio of 50:50 w/v (100%) was also prepared. Sugar syrup was prepared to 72% sugar solids. Starch solution was made by mixing cornstarch with sugar syrup. Powder starch was also produced by mixing cornstarch and icing sugar in the proportion of 1:3. Titanium dioxide was added to the starch solution to give it a white colour. The beeswax was then melted in frytol oil in the proportion of 1 kg beeswax in 4 L frytol oil.

Production of chocolate pebbles

Production of chocolate pebbles was done adopting the method of panned goods of Fabry (1992), which involved three steps.

Preparation and pre-coating of centres

The peanuts, which are the centres of the pebbles were cleaned and calibrated into even sizes. The centres were then fried with cocoa butter and put into a mechanically operated elliptical pan, which rotates on an inclined shaft at an angle of about 40° to the horizontal (Plate 1). The pan has a fan which blows cold air for drying attached to it. The centres were then pre-coated with the gum solution and sugar syrup and then air-dried.

Chocolate coating

This involved the application of chocolate liquid to the centres and dusting with chocolate powder. They were then air-dried. Dusting with chocolate powder ensures proper drying. This was repeated five times to build up the chocolate layer. They were then left overnight for drying. The application of chocolate layer was repeated about 8 - 10 times to obtain a desired number of layers or about half of the total weight of the final product. They were again left overnight for drying

Starch coating

A second gum coating was applied and dried to protect the chocolate layer. The starch solution was applied and dusted with starch powder and air-dried. This was also repeated five times. They were then coloured with a colour solution (colour and sugar syrup) and then polished with the beeswax.

Determination of microbial status and physico-chemical composition of pebbles

Total microbial growth, yeasts and moulds, and coliforms of the products were determined. The results were then compared to internal specification of CPC (Tema, Ghana) for chocolate products. The ash, sugar and moisture contents were determined using MM55 plus (Infrared Engineering) for all the products and the data analyzed using Statgraphics Plus for Analysis of variance (ANOVA).

Sensory analysis

This was done using the triangle test where 40 judges were presented with sets of 3 coded samples of pebbles, two of which were the same. Judges were asked to identify the odd sample in terms of flavour, hardness and smoothness (Stone and Sidel, 1992). Data obtained was analyzed using Binomial distribution. Acceptability test was also conducted .by asking the panelists to determine their overall acceptability using a 9 - point hedonic scale with 1 - 3 = dislike extremely, 4 - 6 = neither like nor dislike and 7 - 9 = like extremely (Stone and Sidel, 1992). Data obtained was analyzed using Binomial distribution.

RESULTS AND DISCUSSIONS

Results of the acute toxicity studies showed that the median lethal dose (LD_{50}) for CG was more than 30 g/kg b.w. Cashew gum had no adverse effect on the rats (Table 1) indicating that CG is not acutely toxic according to World Health Organization (WHO) Acute Hazard Rankings (WHO, 2001) (Table 2). This compares favourably with FAO (1974) report on the acute toxicity of gum Arabic which says that groups of rats fed with gum Arabic in their diet for 62 days showed normal weight gain and food efficiency. Haematological findings and organ weights were also normal. The LD_{50} of gum Arabic was in the range 8 – 18 g/kg b.w. (Booth et al., 1963). Further tests by determining the microbial load of CG also reveal-

Table 1. Visual observation of rats.

	Movement	Appetite	Water intake	Salivation	Diarrhea	Urination
Control	Normal	Normal	Normal	Normal	Absent	Normal
Rat	Normal	Normal	Normal	Normal	Absent	Normal

Table 2. WHO Acute Hazard Rankings (WHO, 2001).

WHO toxicity classification		Rat LD_{50} (mg of chemical per kg body weight	
Class	Description	Solids (oral)	Liquids (oral)
Ia	Extremely hazardous	<5	<20
Ib	Highly hazardous	5-50	20-200
II	Moderately hazardous	50-500	200-2000
III	Slightly hazardous	>500	>2000
IV	Not acutely toxic	>2000	>3000

Table 3. Microbial status of CG from young and mature cashew trees

	Gum from young tree	Gum from mature tree
Total microbial load	<3.0 x 10^3 cfu/ml	<3.4 x 10^3 cfu/ml
Yeasts and moulds	660 cfu/ml	270 cfu/ml
Coliforms	negative	negative

Table 4. Physico-chemical properties of pebbles produced from gum arabic, gum from young cashew trees and gum from mature cashew trees.

Parameter	Gum Arabic	Gum from young tree	Gum from mature tree
Ash (%)	2.46	2.63	2.37
	0.02	0.008	0.005
MC (%)	2.33	2.38	2.76
	0.01	0.09	0.11
Sugar (%)	26.05	29.66	27.55
	0.03	0.7	0.8

*Std dev in italics

Table 5. Microbial status of pebbles produced from the 3 different gums and the standards for foods in general.

	Gum from young cashew tree	Gum from mature cashew tree	Specifications of CPC
TPC	3.0 x 10^2 cfu/ml	3.0 x 10^2 cfu/ml	5.0 x 10^3 cfu/ml
Y/M	0	0	<5 cfu/ml
Coliforms	negative	negative	negative

ed that CG contained an average of 3.2 x 10^3cfu/ml of total microorganisms and 465 cfu/ml of yeasts and moulds (Table 3) which can easily be destroyed by heating. Cashew gum was also found to be free from coliforms, which is an indicator of the presence of disease-causing bacteria.

At a concentration of 80% and higher CG will form a gel (Gyedu-Akoto et al., 2007) and this could not be used in coating the centres of the pebbles since it caused the sticking of centres to each other resulting in uneven surface of products. This led to the use of 66.7% CG solutions in the production of pebbles in stead of 100% used for gum Arabic. Physico-chemical analysis conducted on the three products gave significant differences bet-

Table 6. Results on triangle test (Binomial distribution)

	Category	N	Observed prop	Test prop	Assymp. Sig.(2-tailed)
Hardness Gp 1	1.00	25	0.63	0.50	0.155
Gp 2	2.00	15	0.38		
Total		40	1.00		
Flavour Gp 1	1.00	19	0.48	0.50	0.874
Gp 2	2.00	21	0.53		
Total		40	1.00		
Smoothness Gp 1	1.00	20	0.50	0.50	1.000
Gp 2	2.00	20	0.50		
Total		40	1.00		

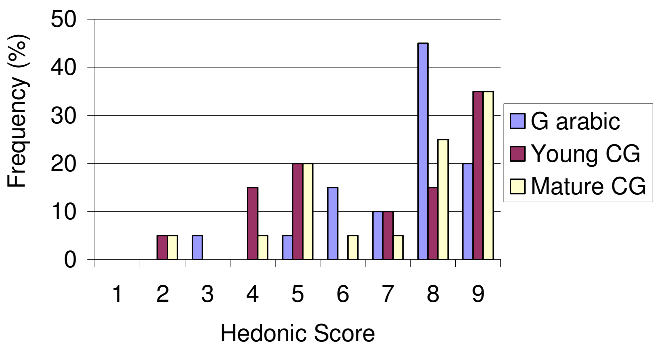

Figure 1. Frequency of hedonic scale scores of pebbles produced with gum arabic, cashew gum from both young and mature trees for overall acceptability (1 = dislike; 9 = like extremely)

ween the products ($p < 0.05$). Multiple comparison tests showed that pebbles produced with gum from both young and mature cashew trees differed significantly from that produced with gum Arabic. The results are presented in Table 4. The moisture and sugar contents of the three products fell within the acceptable levels for chocolate pebbles (Fabry, 1992) which are 1 - 3 and 20 - 30% for moisture and sugar contents respectively. The microbial status of the three products conformed to the internal specification of CPC for chocolate products (Table 5).

Sensory analysis showed no significant difference between the three products in terms of flavour, hardness and smoothness (Table 6). Overall acceptability of the products was similar. The results confirm the similarity of CG and gum Arabic reported by Smith and Montgomery, (1959). Mean scores observed for overall acceptability of the pebbles were 7.4, 6.8 and 7.1 for gum Arabic, gum from young cashew trees and mature trees, respectively. On a hedonic scale, this range varies from "like moderately" to "like extremely" (Mothé and Correia, 2004). The deserved frequency percentage of hedonic scale scores of overall acceptability, obtained for products is presented in figure 1. The frequency of responses are more concentrated between scores of 7 and 9, meaning that pebbles produced with CG compared favourably with that produced with gum Arabic

Conclusion

CG was found to be non-toxic and free from disease-causing bacteria. Results from sensory analysis are indicative of consumers' acceptance to pebbles produced with CG to be similar to that produced with gum Arabic. The study therefore showed that CG can be used as a substitute for gum Arabic in the production of chocolate pebbles.

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