African Journal of Biotechnology Vol. 4 (6), pp. 847-851, June 2005
Available online at http://www.academicjournals.org/AJB
ISSN 1684–5315 © 2005 Academic Journals

Full Length Research Paper

Chemical and sensory attributes of soy-corn milk types

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Accepted 20 April, 2005

Soy-corn milk white type (SCMW) and creamy yellow type (SCMY) were prepared from the blend of blanched and dehulled soybean seeds variety TGX-923-4 and grains of fresh green field maize DMRSLR-White and DMRSLR-Yellow, respectively. Soyamilk (SM) was prepared from the slurry of blanched and dehulled soybean seeds while maize milk types were prepared from the mixed slurry of maize grains types and dehulled soybean cotyledons. The three milk types were analyzed for their total solid, total acidity, total carotenoids, relative density and protein content. Changes in the apparent colloidal stability, pH and sensory scores were monitored for 72 h under storage at room temperature (30±1°C), in refrigerator (6±2°C) and freezer (–4±1°C). There were significant variations in the attributes monitored in the milk types. The soy-corn milk types were more stable than the soyamilk under the conditions of storage. As expected, all milk types decomposed at room temperature after 24 h of storage. The maize milk types were generally more acceptable organoleptically than soyamilk. While the sensory scores of all milk types decreased with increasing storage duration in the refrigerator; frozen soy-corn milk types were significantly scored higher than frozen soyamilk, throughout the duration of storage. Implications of the results were discussed in terms of the potentials of the beverages to combat both protein energy malnutrition and vitamin A deficiency (VAD) disease.

Key words: Soy-corn milk, apparent colloidal stability, protein energy malnutrition, carotenoids, vitamin A deficiency.

INTRODUCTION

Soy-corn milk, a protein beverage, is an aqueous extract of a blend of soyabeans cotyledons and the grains of fresh green field maize (Omueti, 1995; Omueti and Ashaye, 1998). The search for foods of high nutritional quality and balanced content of amino acids, led to the development of this beverage. The beverage being a blend of legume and cereal is considered a nutritionally balanced product according to Bressani (1981). This beverage was found to be highly digestible and widely acceptable by both adults and children (Omueti et al., 2000).

Malnutrition is still a problem in some part of Nigeria (Akinyele et al., 1999). The government is making progress in combating it and thus research efforts are directed towards finding food of high nutritional quality, which are also commonly accepted and widely consumed by large proportion of women of child bearing age and children of weaning ages who are the most vulnerable. Furthermore, vitamin A deficiency (VAD) is still a major problem in children. Therefore the government is focusing attention on projects designed to prevent xerophthalmia resulting from VAD which is a major cause of blindness in young children with attendant high mortality (WHO, 1976). Also VAD is known to be associated with protein energy malnutrition (Reddy, 1981; Hussain et al., 1996).

In Nigeria, yellow maize is widely consumed as roasted fresh green maize, fermented meal for Ogi (gruel) or boiled fresh maize. It is known that carotenes, precursor of Vitamin A, are primarily responsible for the yellow colour of corn (Floyd et al., 1995). Since the soy-corn milk produced from the white corn grains was found more acceptable than soyamilk (Omueti and Ashaye, 1998),

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we envisaged that substituting yellow maize for white maize in the production of soycorn milk beverage will offer additional nutritional advantage in terms of carotene. If such a beverage was equally acceptable as the soy-corn milk (using the white maize), the product would be suitable for combating malnutrition as well as preventing VAD. The aim of this work was to compare the chemical and sensory qualities of soy-corn milk white type (SCMW), creamy yellow type (SCMY) and soyamilk (SM) under the various conditions in which soyamilk is sold to consumers in the Nigerian markets. Thus we report on the comparative assessment of the soy-corn milk types and soymilk in terms of chemical and sensory attributes.

MATERIALS AND METHODS

Soyamilk and soy-corn milk preparation

Grains of freshly harvested green field maize varieties DMRSLR-White and DMR SLR-Yellow, seeds of soybean variety TGX-92-2E and sugar were used for the preparation of the beverages. Milk extract was prepared following the method previously described (Omueti and Ashaye, 1998). Briefly, the maize varieties DMRSLR-White and DMRSLR-Yellow were harvested at eating stage, when the grains were most milky and juicy. The grains were separated from the cob and cleaned to remove hairs and other extraneous materials. Healthy and unbroken soybean seeds were soaked overnight (16 – 17 h), drained and added directly into boiling water (1:3, seed:water). The seeds were blanched for 15 min after which they were transferred into cold tap water, dehulled and drained. 300 g of the seeds were milled. The soyamilk slurry was mixed with water while breaking lumps to allow for fast sieving. Water was added to the slurry, sieved and the filtrate collected yielding a total volume of 1.5 L. The filtrate was boiled for 8-10 min, resieved and cooled at room temperature (30±1°C).

Corn grain and dehulled soybean cotyledons were weighed separately and combined in ratio 1:3 (corn to soybean). The soy-corn blend (300 g) was also milled and treated as for soybean milk preparation.

Chemical analysis

Total solid, total acidity and pH were determined as previously described (Egan et al., 1981). Total carotenoids were determined using a volume to volume purified hexane to liquid milk extraction of total carotenoids. Absorbance was measured at 410 nm using β–carotene dissolved in hexane as standard. Apparent colloidal stability was measured by the method previously described (Omueti and Ashaye, 1998). Briefly described, the milk samples were placed in graduated tubes held in racks in the refrigerator undisturbed at 3.8 to 4°C. Changes in apparent colloidal stability were indicated by separation into two layers (Nelson et al., 1976). Level of visible line of demarcation between the settled and remaining portion of the milk solution was measured in (height in cm). Milk samples were stored at room (30±1°C) refrigeration (6±2°C) and freezing (–4±1°C). Frozen milk samples were first defrosted at room temperature then measured for apparent colloidal stability at each period of determination. As is expected, it was not feasible to follow apparent colloidal stability and pH of milk times at room temperature as a result of decomposition of samples. Protein was determined by standard method (AOAC, 1984) using dried (50°C) samples.

Sensory evaluation

Twelve tasters (trained and usually used in the Institute for sensory evaluation) assessed the three milk types, SCMW, SCMY and SM. The three milk types were scored for colour, taste, viscosity, flavour and overall acceptability. The test was conducted under artificial light generated from 4ft florescent tube in an air conditioned 16 feet by 16 feet sensory evaluation room. A white coloured painted cubicle housed each taster during the evaluation. Milk samples were served chilled. Scores were based on a hedonic scale of 1 to 9 where 1 = dislike very much 9 = like very much (Watts et al., 1989).

Statistical analysis

Data were analysed using statistical tools on SAS computer package. For apparent colloidal stability, a three-way factorial experimental method was used based on (milk types x duration of storage x level of unseparated liquid). Also the pH data were processed using a three way analysis of variance based on (milk types x duration of storage x pH).

RESULTS AND DISCUSSION

Chemical attributes of milk types

The differences between the values of total solid for soy-corn milk types SCMW and SCMY and SM (Table 1) could be attributed to higher level of suspended particles in the soy-corn milk types than in the SM (Nelson et al., 1976). The acidic nature of maize proteins (zein) could be responsible for the higher total acidity of the soy-corn-milk types compared with the value for SM (Hosney, 1994). Protein was lowest ($P<0.05$) in SCMY than in both SCMW and SM, which had similar values. Differences and similarity observed in the protein content may be attributed to varietal effects of protein content of maize. Comparative level of protein in soy-corn milk types and SM is nutritionally significant in terms of the potentials of these beverages to contribute to increased protein intake of consumers.

The observed differences in total carotenoids of the three types of protein beverages are expected due to the fact that carotenes and xanthophylls are primarily responsible for the yellow colour of corn (Floyd et al., 1995).Therefore SCMY gave higher level of total carotenoids than SM and SCMW. It has been reported that vitamin A status can be influenced by the diet (Byerly, 1977). It thus means that the high carotene level will result into increased level of vitamin A in the beverage. Since children suffering from xerophthalmia were also found to be malnourished (Reddy, 1981) SCMY extract which is both rich in high quality protein and carotenoids (vitamin A precursors) can be used to

Table 1. Chemical attributes of milk types.

Milk types	Total solids (%)	Total acidity (%)	Protein (%)	Total carotenoids (mg/100 g)	Relative density
SCMW	9.38	0.063	29.30	1.73	1.01
SCMY	9.48	0.057	25.33	2.89	1.01
SM	8.82	0.04	29.49	1.85	1.05

Table 2. Effects of duration of storage on apparent colloidal stability (cm) of milk types.

Time (h)	Refrigerator			Freezer		
	SCMW	SCMY	SM	SCMW	SCMY	SM
0	10.3	10.3	10.3	10.3	10.3	10.3
24	8.4	8.5	3.3	8.4	8.4	6.4
48	6.0	5.9	3.3	6.8	6.5	3.7
72	5.7	5.8	3.3	6.8	6.5	3.7

Table 3. Effects of duration of storage on pH of milk types.

Time (h)	Refrigerator			Freezer		
	SCMW	SCMY	SM	SCMW	SCMY	SM
0	6.70	6.70	6.80	6.70	6.80	6.80
24	6.50	6.50	6.50	6.30	6.40	6.50
48	6.40	6.40	6.47	6.30	6.30	6.37
72	6.20	6.30	6.47	4.53	4.50	4.67

combat both protein energy malnutrition and VAD disease.

The relative density values of all milk types were not significantly different from each other. The results could be attributed to uniform dispersion of solutes rather than the magnitude of total solid which varied with milk types (Iwoha and Umunnakwe, 1997).

Colloidal stability and pH of milk types

Apparent colloidal stability and pH of milk types during storage in the refrigerator and freezer are shown in Tables 2 and 3, respectively. For all milk types apparent colloidal stability and pH decreased significantly $P<0.05$ from zero to 72 h during storage. In all milk types, the initial rate of decrease in apparent colloidal stability from zero to 24 h during storage in samples stored in the refrigerator and freezer can be attributed to growth of microorganisms in the beverages after processing and packaging at ambient temperature. Metabolic activities in food products increase at high temperatures leading to breakdown in cellular structures (Gaman and Sherrington, 1977). Similar values of apparent colloidal stability were obtained for SCMW and SCMY beverages stored in the refrigerator and freezer. The results could be attributed to uniform dispersion of solutes in the two milk types during storage (Iwoha and Umunnakwe,

Table 4. Sensory attributes of milk types during storage temperature.

Attribute	Milk types	Refrigerator			Freezer		
		24 h	48 h	72 h	24 h	48 h	72 h
Appearance	SCMW	7.4	4.4	3.4	7.6	7.1	6.7
	SCMY	7.3	4.6	3.3	7.6	7.0	7.0
	SM	7.1	5.4	3.1	7.0	7.0	6.8
Flavour	SCMW	7.1	3.6	3.3	6.9	6.9	6.7
	SCMY	7.2	3.3	2.8	6.8	6.8	6.6
	SM	6.1	3.6	2.3	6.4	6.4	6.4
Mouth feel	SCMW	6.4	2.8	2.7	6.9	5.6	5.2
	SCMY	5.9	3.2	2.3	6.3	5.6	5.1
	SM	6.1	5.0	2.5	5.9	5.1	4.8
Overall Acceptability	SCMW	5.0	4.3	2.7	6.1	5.6	5.6
	SCMY	4.9	4.0	2.4	6.3	5.7	5.4
	SM	4.5	3.0	2.2	6.2	5.0	4.8

1997). It was also observed that apparent colloidal stability values remained constant for SM after 24 h of storage at 6°C and –4°C indicating that textural breakdown was complete within 24 h in this beverage. For SCMW and SCMY however, slow decline in apparent colloidal stability was observed indicating that deterioration was gradual in the maize-based beverages during storage.

Results obtained (Table 2) showed that the maize-based beverages appeared to be more stable than the SM under cold and freezing conditions. The results could be attributed to the nature of protein complexes in the beverage types. Formation of hydrophilic protein-lipid complexes has been implicated in soymilk colloidal stability (Nelson et al., 1976). High level of glutamic acid is believed to be associated with corn proteins (Hosney, 1994). Since glutamic acid is hydrophilic in nature, higher values of apparent colloidal stability for SCMW and SCMY than for SM could be attributed to stronger hydrophilic protein-lipid complexes in the corn based beverages (Nelson et al., 1976). There is occurrence of higher content of starch in the SCMW and SCMY than in SM due to their carbohydrate components. Thus, the gelation of starch in the maize-based beverages under heat could also account for their observed higher colloidal stability in terms of apparent colloidal stability values compared with SM (Iwoha et al., 1997).

The beverages were unstable at room temperature (30±1°C) where microbial activities become very virile and their decompositional components reaching the highest level (Truong and Mendoza, 1982). Under reduced temperature (Table 3) observed gradual decrease in pH for maize milk types refrigerated and frozen respectively could be indicative of the beverages relative stability (Gaman and Sherrington, 1977). The presence of high level of acidic amino acids in corn based beverages (Hosney, 1994) would account for the lower pH of SCMW and SCMY extracts than that of SM.

Sensory attributes of milk types

Milk types were organoleptically assessed for appearance, colour, flavour, mouth feel and overall acceptability (Table 4). Tasters gave lower sensory scores for all milk types with longer duration of storage and for refrigerated than for frozen beverages. There were also lower sensory scores for SM than for SCMW and SCMY. The observed results could be attributed to higher level of deteroration in SM than in the maize-based beverages. The frozen beverages tasted better than the refrigerated samples as a result of less degradation activities at freezing than at refrigeration. Other authors had also attributed inferior sensory qualities of soymilk stored at higher temperatures to faster degradative activities in the milk at the storage temperatures (Iwoha and Umunnakwe, 1997; Truong and Mendoza, 1982).

Conclusion

Our results had shown that the two types of soy-corn milk are more acceptable than soyamilk. There was no adverse effect in the organolepletic qualities of soy-corn milk using yellow maize. Therefore the use of yellow maize affords an advantage of incorporating carotenoids which are precussors of vitamin A into a protein-rich beverage, offering dual nutritional advantages in combating protein energy malnutrition and vitamin A deficiency disease.

The simplicity in the preparation of these beverages in a typical home can promote its adoption in rural areas as a means to enhance protein and vitamin A intake in the diets. However, the study emphasizes the constraints in the use of this beverage in terms of its poor storability qualities at ambient temperatures. The beverage can, however, retain its qualities for longer duration at cold temperatures such as in refrigerators and freezers. Daily preparation of the milk in rural locations is recommended. It is also recommended that the three types of beverages be utilized to meet the nutritional needs of the people where dairy milk is not easily affordable.

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