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IMPACTS OF COAGULANTS ON QUALITY OF SOFT CHEESE PRODUCED FROM COW-SOY MILK BLENDS

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ABSTRACT

Production of cheese at household level involved the use of different locally produced coagulants which include alum, Sodom apple and fermented maize liquor. Their effects on quality of cheese made from blends of cow-soy milk are sparse. This work investigated effect of coagulants on soft cheese produced from cow soy blends. Soft cheese samples were produced from cow-soy milk blends (90:10%). The cheese was coagulated using three locally available coagulants {juice of Sodom apple (Calotropis procera), aqueous solution of Potassium alum and fermented maize liquor}. Samples were analysed for yield, pH, proximate and mineral contents. Microbial analysis and sensory attributes were also determined. The yield obtained ranged from 38.7 to 39.0%. Highest yield was obtained from Sodom apple coagulated cheese sample. Cheese produced using fermented maize liquor had the highest pH (6.07) while Sodom apple and alum coagulated cheese had the pH values of 6.83 and 6.97, respectively. The moisture contents of the produced cow-soy cheese ranged from 70.4 to 73.57%. The protein content of the cheese samples coagulated with alum had the highest (12.97%) in all the samples. There was no fiber in all the cheese samples produced. Calcium contents obtained from the three samples ranged between 171.67 and 185.00 mg/100 g. The iron content of cheese coagulated with fermented maize liquor (3.63 mg) was significantly ($p < 0.05$) higher than that of alum coagulated (3.23 mg/100 g) and Sodom apple coagulated cheese (3.33 mg/100 g). Higher microbial load was recorded in cheese samples coagulated with FML. The sensory attributes of the cheese samples varied with different coagulants. This indicates that the type of coagulant used in cheese-making has effect on the yield, pH some nutritional and sensory attributes of cheese.

Keywords: soft cheese, soy-cow milk blends, coagulants, soya beans.

Introduction

Cow milk is the predominant raw material used for manufacturing dairy products such as cheese, but cow milk is expensive and becoming scarce due to increase in population (Meenakshi and Verma, 1995). Malnutrition is a major problem in most developing countries causing 2.2 million deaths for children in less than 5 years of age (Black *et al*., 2008). In an attempt to reduce this malnutrition, many complementary foods had been provided as substitutes and some have been reported to be nutritionally inadequate to malnourished children due to its content of anti-nutrient factors (phytate, tannins and antitrypsin), suboptimal micronutrient and the lack of animal protein (Pee and Bloem, 2008). Hoppe *et al*. (2006) reported that animal foods especially milk are important for linear growth and development of young children. In other to strike a balance and ameliorate the problem associated with this, cow milk can be supplemented with soy-milk.

Cheese is one of the numerous products from the processing of milk and is a means of preserving essential nutrients in milk. Supplementing cow milk with soy milk will improve the nutritional value of the cheese and also enhance the use of soybean in food industries. Soy-milk has some nutritional advantages such as little or no saturated fat and little or no cholesterol (Descheemaeker and Debruyne, 2001) has potential to reduce the risk of atherosclerosis (Setchell and Cassidy, 1999). It does not contain lactose making it a good choice for lactose intolerant people; it is a source of lecithin and contains isoflavones (Anderson *et al*., 1999). Soya proteins are unique among plant proteins by virtue of their relatively high biological value and essential amino acid content (Meenakshi and Verma, 1995). In production of cheese, the quality of cheese is determined by milk clotting properties and the type of coagulants. Obatolu (2008) reported that the yield and quality of tofu are influenced by soybean varieties, soybean quality processing conditions and coagulants. The

coagulant used in cheese making has a dual role: the primary function is to coagulate milk to produce cheese curd and a small proportion of the coagulant is carried over into the cheese. This residual coagulant remains proteolytically active in most aged cheeses and plays an important role in the development of texture and flavour and to some extent in the stability of the resulting cheese. It also determines the yield and also the stability of cheese (Cai and Chang, 1998). The use of calf rennet is banned in some countries due to religious sentiments and microbial rennet is being used for cheese manufacture (Meenakshi and Verma, 1994). The use of the latter is however expensive and the technical knowhow are rare especially in developing countries. It is therefore important to assess and evaluate the use of some locally available coagulants and their effects on quality of cow-soy cheese. This work is aimed at investigating the effects of coagulants on yield and some quality attributes of soft cheese produced from blends of cow and soy milk.

Materials and Method

Procurement of raw materials

Fresh cow milk was obtained from a matured cow with no particular breed type from a local dairy farm in Ibadan. Soy beans of tax grain variety were procured from Bodija market in Ibadan. Sodom apple plant was obtained from Awotan Area, Ibadan in a garden purposely grown for *Calotropis* plants. Alum of industrial grade was used and fermented maize liquor was obtained from ogi processing. All the chemicals used for analyses were of standard grade.

Production of soy milk

Soymilk was produced from soybean as described by Omotosho *et al*. 2011. Two kilogram (2 kg) of dry beans were sorted, cleaned and soaked in 5 liters of water for 6 h. The soaked beans were wet milled and about 500 ml of water was added to give the desired paste consistency. The resulting slurry was sieved to remove hulls and other fibrous particles. It was cooked for 30 minutes in order to improve its palatability, inactivate soy trypsin inhibitor and improve its flavour. The soymilk obtained was opaque, off-white in colour, and approximately the same consistency as cow's milk.

Production of cow-soy cheese

Raw fresh cow milk (3600 ml) was pasteurized at 63°C for 30 minutes and 400 ml of the produced soy milk was added in the ratio 90:10 and the mixture was homogenized. The Sodom apple leaves were thoroughly washed with water and milled in a Kenwood blender. It was poured into a clean muslin cloth so as to extract the Sodom apple juice. Ten grams of alum was dissolved in 100 ml of distilled water. Fermented maize liquor (FML) was obtained from wet milled-ogi that had earlier been sieved and fermented for three days. One liter of cow-soy milk (90:10) blend was boiled in a pot and 10 mm of Sodom apple coagulant was added to it. It was stirred and heated at 95°C for 20 minutes until the curd was formed. The procedure was repeated for the other two coagulants and curds were poured into a clean muslin cloth to drain off the whey as shown in Fig 1 (Omotosho *et al*., 2011). The resulting curd was cut with cheese knives.

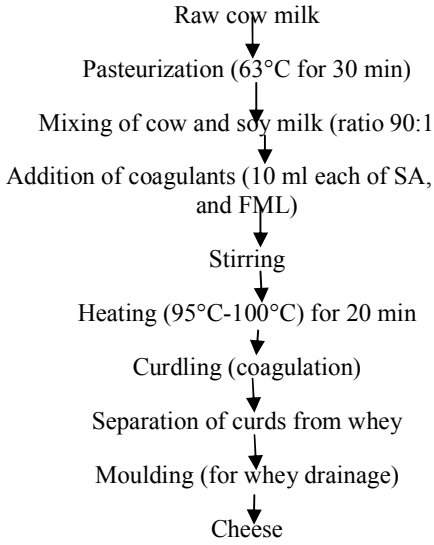

Fig. 1 Flowchart for the production of cheese from cow-soy milk

Analyses

Determination of yield and pH

The amount of cheese produced per liter of milk with different coagulants were weighed on a weighing machine and recorded as the yield. The pH was determined using a pH meter (AOAC, 2000).

Proximate Analysis

The moisture content of the cheese sample was determined gravimetrically while protein, fat, crude fiber, ash contents were determined as described by AOAC (2000). Carbohydrate was determined by difference.

Determination of minerals

Samples were first incinerated to obtain ash. The ash obtained was digested with 1% HNO_3 and filtered with Whatman no 4 filter paper. Iron, calcium, aluminium and phosphorus were determined using atomic absorption spectrophotometer (Buck 205 Scientific AAS) and

compared with absorption of standards of these minerals (AOAC, 2000).

Microbiological Analysis

Total viable and coliform counts were determined using nutrients and Maconkey agar respectively. One mL aliquot portion of each sample was aseptically withdrawn after serial dilution into sterilized Petri dishes and the already sterilized agars were poured in to the plates. The plates were inverted after setting and incubated at 30°C for 48 hours (Collins, 1989). Colonies were counted using Stuart Scientific Colony Counter.

Sensory evaluation

Cheeses made from different coagulants were evaluated for sensory attributes. Twenty untrained panelists made up of both sexes were selected. The panelists were requested to record their judgment. Attributes such as colour, taste and aroma were rated using a 7- point hedonic scale form. The data obtained were analyzed statistically using analysis of variance (ANOVA) and means were separated using Duncan's multiple range test (SPSS, 2006).

Result and Discussion

Yield

The yield obtained from cheese coagulated using three coagulants was expressed as percentage (Table 1). The yield ranged between 38.7 and 39% with cheese produced using Sodom apple coagulant recorded the highest yield followed by cheese coagulated with alum while samples coagulated with FML had the lowest yield. However, the differences were not significant ($p>0.05$). This result agreed with the findings of Omotosho *et al*. (2011) who reported highest value in cheese coagulated with Sodom apple. Yields obtained from this study were higher than 7.6-18.3% reported by Oboh (2006) but lower than values reported by Shokunbi *et al*. (2011). The latter showed that cheese coagulated using alum had higher yield than the FML-coagulated cheese. Variations may however, be due to differences in the processing methods and the use of cow-soy blends. Emmons and Binns (1990) reported that the yield differences as small as 0.1% is of economic importance for the cheese industry.

pH

The pH value of the three samples ranges between 6.07 in FML-coagulated cheese to 6.97 in alum-coagulated cheese. The differences in pH are reflections of the pH of coagulants. Lowest pH value observed in the FML-coagulated cheese was due to the acidic condition of the coagulant. All the samples were significantly ($p < 0.05$) different from one another (Table 1).

Proximate composition

The moisture content of the produced cow-soy cheese was significantly ($p < 0.05$) different from each other. The values obtained ranged from 70.4 to 73.57%. There was significant ($p < 0.05$) difference in the moisture content of all the cheeses produced. FML cheese had the highest value while the alum coagulated cheese had the lowest. The variation in moisture content could be due to the unique coagulating properties of the coagulants used (Shokunmbi *et al*. 2011). Ndatsu and Olalekan (2012) observed variation in the moisture contents of tofu prepared using different coagulants. The authors further attributed the variations to differences in gel network which affected the water holding capacity of protein gels.

There was a significant difference ($p<0.05$) in the protein contents of all the cheese produced and the values ranged from 10.87% in fermented maize liquor cheese to 12.97% in alum coagulated cheese. This could be due to high soluble characteristics possessed by common alum which created a better coagulating environment for the protein present in the cheese. However, the protein contents obtained from all the cheeses produced in this study are higher than the values obtained in soy cheese produced by Omotosho *et al*. (2011).

The fat contents of the soy-cow cheese samples ranged between 8.23 to 8.43%. The fat content of the fermented liquor cheese (8.23%) was significantly ($p < 0.05$) lower than other two samples while there was no significant ($p > 0.05$) difference in the fat content of alum (8.43%) and Sodom apple cheese (8.37%). Cheese, when fresh has a fat content of up to 12% level. Values obtained were lower than fat content of fresh cheese. The reduction in fat content could be attributed to substitution of cow milk with 10% soy-milk in the cheese produced.

The result revealed that there is no fiber in all the cheese samples including the soy-cow milk. Although, soybean is a good source of fiber, the sieving process in soymilk production could be responsible for the zero content recorded.

The ash contents of all the cheese samples were significantly ($p < 0.05$) different from one another. The ash contents for Sodom apple coagulated cheese and fermented maize liquor cheese are 1.50% and 1.57% respectively. Alum cheese had highest ash content of 1.9%. This is due to the fact that alum is made up of different mineral elements. This finding agreed with report of Ndatsu and Olalekan (2012) who observed significant higher ash contents in alum coagulated tofu than steep water coagulated tofu.

The carbohydrate content of the cheese produced using FML was 5.77% which was significantly ($p < 0.05$) lower than others. There was no significant difference in the values obtained

from alum (6.37%) and Sodom apple (6.33%) coagulated cheeses. The prepared soy-cow cheeses have carbohydrates values ranging from 5.77 to 6.37%. Reduction in carbohydrates contents could be due to substitution of cow milk with 10% soy-milk in the cheese produced.

Mineral contents

The results of mineral contents are shown in Table 2. The three samples have high calcium contents ranging from 171.67 to 185.00 mg/100 g (Table 2). This is a reflection of the high calcium content in milk. The iron content of FML-coagulated cheese (3.63 mg/100 g) was significantly ($p < 0.05$) higher than the iron content of alum (3.23 mg/100 g) and Sodom apple coagulated cheese (3.33mg/100 g). The phosphorus content of all the samples was not significantly different ($p>0.05$). However, alum cheese had a value of 153.33 mg/100 g while Sodom apple and FML cheese had the same value of 155.00 mg/100 g. The aluminium contents of the three samples were significantly different ($p<0.05$) from one another. Moreover, alum cheese contained a high content of aluminium (2.43 mg/100 g) compared to other cheese which had a relatively low amount of aluminium (0.4 mg/100 g for Sodom apple cheese and 0.3 mg/100 g for fermented maize liquor cheese). The high content of aluminium in the alum coagulated cheese is attributed to presence of this compound in alum used as coagulant. This could be attributed to the higher ash content (1.9%) reported for the alum coagulated cheese (Table 1).

Table 1 Yield, pH and proximate analysis of cow soy cheese coagulated with three different coagulants

Parameters/ Samples	Yield (%)	pH	Moisture content (%)	Protein content	Ether extracts (%)	Crude fiber	Ash (%)	CHO (%)
Sodom apple	39.0a	6.83c	71.67b	12.07c	8.43a	0.00a	1.90c	6.33b
Alum	38.9a	6.97b	70.40a	12.97b	8.37c	0 .00a	1.50a	6.37b
FML	38.7a	6.07a	73.57c	10.87a	8.23a	0 .00a	1.57b	5.77a

Means with the same subscripts along the column are not significantly ($P > 0.05$) different using Duncan multiple range test
FML: Fermented Maize Liquor

Table 2. Mineral composition of cheese from soy-cow milk blend

Mineral element	Ca (mg/100 g)	Fe (mg/100 g)	P (mg/100 g)	Al (mg/100 g)
Sodom apple	171.67a	3.33a	153.33a	2.43c
Alum	185.00b	3.23b	155.00a	0.40b
FM Liquor	185.00b	3.63c	155.00a	0.30a

Means with the same subscripts along the column are not significantly ($P > 0.05$) different using Duncan multiple range test
FML: Fermented Maize Liquor

Microbial attributes

The microbial loads for alum, Sodom apple and FML coagulated cheeses were 7.5×10^3, 1.0×10^4 and 4.5×10^6 cfu/ml, respectively while the microbial load for the cow soy milk was 6.0×10^5 cfu/ml. The high microbial load of the fermented maize liquor coagulated cheese could be due to inherent microbial flora already present in fermented maize liquor used as coagulant, thus increasing the number of microorganisms present. Alum-coagulated cheese had the lowest microbial count which could be due to potentials of alum in coagulating the cell walls of microbes. There was no growth in any of the samples including the control, thus showing the effectiveness of pasteurization. The samples were free of feacal contamination and this implies that the cheese was hygienically prepared and safe for consumption.

Sensory evaluation

The panelists rated alum coagulated cheese higher in terms of colour than other two products while the rating for Sodom apple coagulated cheese samples were not significantly different from the other two samples (Table 3). The cheese samples coagulated with Sodom apple had the highest score for taste compared with other cheese samples. Alum and fermented maize liquor coagulated cheese samples recorded 4.80 and 4.65 respectively. The lowest value obtained for taste in cheese product could be due to fermented nature of the coagulant which imparted its flavour in the final product. Ndatsu and Olalekan (2012) also reported least score for taste in tofu coagulated with maize steep water. This was attributed to the heterogenous nature of the steep water which could have affected the taste of tofu produced.

Table 3. Sensory evaluation of soy- cow cheese samples with different coagulants

Sample /parameters	Colour	Taste	Aroma
Alum	5.95b	4.80a	5.40b
Sodom apple	5.55ab	5.65b	5.15a
FML	5.15a	4.65a	5.55b

Means with the same subscripts are not significantly (P > 0.05) different using Duncan multiple range test.
FML: Fermented Maize Liquor

Conclusion

The results of the experimental investigation indicated that cheese could be coagulated with using these three locally available coagulants (Sodom apple, Alum and fermented maize liquor) with resultant effects on the yield, nutritional and microbiological attributes of the cheese. Panelist's preference for cheese produced from different coagulants varied with sensory parameters. This therefore proves that the type of coagulant used in cheese making affect the organoleptic characteristic of cheese. Cheese coagulated from Sodom apple plant had the highest yield value. The fermented maize liquor which is considered as a waste product proved to be a good raw material for the production of cheese.

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