Trop. Anim. Prod. Invest. 15 (1): 15-18 (2012)
ISSN: 1115-2540
http://animalsci.agric.ui.edu.ng/TAPI/index.php/tapijournal/index

ORIGINAL RESEARCH ARTICLE

Chemical composition, sensory properties and yield of soft cheese precipitated with different coagulants

***Olorunnisomo, O.A. and. Ikpinyang, E.A**

Department of Animal Science, University of Ibadan, Ibadan, Nigeria
**Correspondence author Email: sholanisomo@yahoo.com*

ABSTRACT

The study was conducted to evaluate the coagulation properties of pineapple (PA), lime (LM), mango fruit juice (MA) and moringa seed extract (MS) as alternatives to sodom apple (SA, Calotropis procera) for the production of Nigerian soft cheese, popularly called wara. Chemical composition, organoleptic properties, coagulation time and yield of cheese precipitated with SA, PA, LM, MA and MS were evaluated using a completely randomized design. Results showed that chemical composition, sensory properties and yield of cheese was influenced by the coagulant used. Total solids in cheese varied from 34.07 - 36.18 % with SA having the highest value and MS the least. Protein varied from 13.83 - 14.67 % with SA and MS having the highest values, and LM the least. Fat in cheese varied from 9.13 - 10.37 % with MS having the highest value and SA the least. Organoleptic scores (colour, aroma, taste, and texture) revealed that acceptability of cheese by panelists was in the order: PA > SA > MA > LM > MS. Coagulation time was 71, 66, 61, 57 and 45 minutes while cheese yield was 23.4, 33.7, 28.2, 42.0 and 36.1% for MS, MA, LM, SA, and PA respectively. Coagulation time was shortest (57 minutes) for PA and longest (71 minutes) for MS. Cheese yield was highest (42 %) in SA and least (23 %) in MS. While all coagulants used showed potential for replacing SA in making the Nigerian soft cheese, better results were obtained with PA and MA.

Keywords: cheese yield, coagulant, milk, organoleptic properties, *wara*

INTRODUCTION

Cheese is a dairy food of high culinary and nutritive value among humans all over the world. It is obtained through the precipitation and concentration of milk proteins and occlusion of fat and moisture (Scott, 1986; Law and Tamime, 2010). Cheese contributes high quality protein, fatty acids, calcium, phosphorus and vitamins to the human diets. Over 2,000 varieties of cheese have evolved worldwide, depending on processes adopted, coagulants and additives used (O'Connor, 1993). Milk coagulant is vital to the cheese-making process; and is responsible for the precipitation of milk into curds and whey. The curds are pressed and further processed into different forms of cheese. Although milk could be precipitated using acids, cheese is traditionally coagulated using enzymes. Until recent times, the main coagulant used in cheese-making was rennet extracted from the abomasum of a pre-ruminant calf with its principal enzyme called rennin or chymosin (O'Connor, 1993; Law and Tamime, 2010). This resulted in serious economic losses since calves had to be slaughtered to obtain the juice. Rennet could also be obtained from microbial and plant sources such as papaya (papain), pineapple (bromelin), castor oil seeds (ricin), latex of the fig tree and *Calotropis procera* (calotropain). Acetic acid, citric acid, lactic acid, vinegar and lemon juice have also been used in the manufacture of cheese. Plant extracts have been shown to be suitable mainly for soft and fresh cheese which is consumed within a few days of production because it tends to develop excessive acid, bitter flavour and texture defects as the cheese ages (Roseiro *et al*., 2003). *Wara* is a fresh cheese from West Africa, which is precipitated with the leaf of *Calotropis procera* (O'Connor and Tripathi, 1991). Over dependence on this plant as the main source of coagulant for soft cheese in Nigeria may present a serious problem in future if the plant becomes scarce. This makes it imperative to look for alternative coagulants for soft cheese manufacture. This study therefore evaluated the yield, quality and sensory properties of soft cheese precipitated with juice extracts of sodom apple leaves, pineapple fruit, lime fruit, mango fruit, and moringa seed extract.

MATERIALS AND METHODS

The fresh milk used for this experiment was pooled from the milk of zebu cows at the Dairy Farm of the University of Ibadan and Ijaye Fulani settlement, near Ibadan, Nigeria.

Table 1: Chemical composition (%) of the different cheese samples

Parameters	SA	PA	LM	MA	MS	SEM
Total solids	36.18[a]	35.35[ab]	34.10[c]	35.13[b]	34.07[c]	0.59
Protein	14.67[a]	14.13[ab]	13.83[b]	14.00[ab]	14.67[a]	0.12
Fat	9.13[b]	9.38[b]	9.33[b]	9.35[b]	10.37[a]	0.28
Ash	2.17	2.07	2.12	2.03	2.08	0.07
Lactose	0.57[a]	0.57[a]	0.52[a]	0.50[ab]	0.42[b]	0.03
Casein	11.80[a]	11.38[ab]	11.08[b]	11.27[ab]	11.80[a]	0.18

Values with different superscripts within the same row are significantly different ($p < 0.05$). SA: sodom apple leaf extract; PA: pineapple fruit extract; LM: lime fruit extract; MA: mango fruit extract; MS: moringa seed extract

Preparation of juice extracts

Extracts of sodom apple (SA) was obtained by crushing 60g of fresh mature leaves using a mortar and pestle. The crushed leaves were soaked in 100mL of warm water (65 ^{o}C) for 10 minutes and strained through a sieve into a labeled bottle. Pineapple fruit (PA) juice was obtained from semi-ripe pineapple fruit, washed and squeezed using a juice extractor. The extracted juice was filtered using a muslin cloth. Washed lime fruit (LM) was also squeezed and filtered to obtain the juice while washed unripe mango fruits (MA) were peeled to obtain the pulp which was mixed with distilled water at ratio 4:1 (juice: water, v/v), squeezed through a juice extractor and filtered into a labeled bottle. Moringa seed (MS) was ground into powder and 500g was soaked in 1L of distilled water for 12 hours with occasional agitation after which it was filtered into a labeled bottle to obtain the extract.

Preparation of cheese

Raw milk was heated to a temperature of 50 ^{o}C inside a metal pot placed on a low-intensity burner (regulated stove; ThermoStar, China). The warm milk was divided into 5 parts of 1,000 mL each and 20 mL of extract was added to each part. Heating of each part of milk continued with intermittent stirring until boiling and coagulation was achieved. The curd so formed was poured into a sieve of 0.2mm to drain the whey. Draining of the whey lasted for 45 minutes with occasional flipping of the cheese from side to side for efficient drainage.

Physical and chemical evaluation of cheese

Sensory evaluation was done 3 hrs after cheese was formed by 27 semi-trained panelists drawn from students and staff of the Department of Animal Science, University of Ibadan. The colour, aroma, taste, and texture of cheese were used to judge acceptability using a 9-point hedonic scale (Piggott, 1984). Chemical analysis was done 24 hrs after cheese production and refrigerated weight change in each treatment curd were recorded at 36 and 72 hrs after production. The pH of the extracts, milk and cheese was measured using a pH meter. Coagulation time (CT), cheese weight, volume of whey and shelf stability (refrigeration weight changes) of the cheese samples were also measured as described by O'Connor (1993). The chemical analysis of the milk and cheese samples for total solid, crude protein, fat, ash, casein and lactose contents were carried out according to the AOAC (1995).

Statistical analysis

The experimental design adopted for this study was the completely randomized design (CRD). Treatments were replicated three times and data obtained were subjected to analysis of variance using the SAS (2000) software. Significant means were separated using Duncan's Multiple Range F-test option of the same software.

RESULTS AND DISCUSSION

Presented in Table 1 is the chemical composition of the cheese. The result showed that the total solids obtained for SA (36.18 %) was similar ($p > 0.05$) to that of PA **(**35.35 %**)** but significantly ($p < 0.05$) higher than that of MA (35.13 %), LM (34.10 %) and MS (34.07 %).

Table 2: Sensory properties of cheese precipitated with different coagulants

Parameters	SA	PA	LM	MA	MS	SEM
Colour	7.24[a]	7.06[a]	7.06[a]	6.41[b]	7.24[a]	0.21
Aroma	6.06[a]	6.18[a]	5.29[b]	6.18[a]	4.76[c]	0.17
Taste	6.29[a]	6.06[a]	4.71[bc]	5.12[b]	4.41[c]	0.14
Texture	6.76[a]	7.18[a]	3.53[c]	5.41[b]	3.35[c]	0.17
Overall acceptability	6.59[a]	6.62[a]	5.15[c]	5.78[b]	4.94[c]	0.16

Values represent mean of triplicate reading. Values with different superscripts within the same row are significantly different ($p < 0.05$). SA: sodom apple leaves extract; PA: pineapple fruit extract; LM: lime fruit extract; MA: mango fruit extract; MS: moringa seed extract

Table 3: Coagulation time, pH and yield of cheese precipitated with different extracts

Parameter	SA	PA	LM	MA	MS	SEM
Coagulation time (minutes)	56.67^{d}	45.33^{e}	61.00^{c}	66.00^{b}	70.67^{a}	1.20
Coagulation pH	6.47^{a}	6.33^{a}	4.60^{c}	5.57^{b}	5.90^{ab}	0.18
Weight of cheese (g) from 1kg of milk	420.43^{a}	361.27^{b}	281.93^{d}	336.66^{c}	234.07^{e}	6.23
Cheese yield (%)	42.04	36.13	28.20	33.67	23.41	0.65

Values with different superscripts within the same row are significantly different ($p<0.05$). SA: sodom apple leaves extract; PA: pineapple fruit extract; LM: lime fruit extract; MA: mango fruit extract; MS: moringa seed extract

The total solids in cheese depend on the ability of the coagulant to precipitate the protein and fat in the milk (Ebing and Rutgers, 2006). The protein contents in SA (14.67 %) and MS (14.67 %) were similar to that of PA (14.13 %) and MA (14.00 %) but significantly higher than that of LM (13.83 %). This may be due to the ability of these coagulants to precipitate higher amounts of milk protein than LM. The fat content in SA, PA, LM and MA (9.13 – 9.38 %) was similar but significantly ($p < 0.05$) higher in MS (10.37 %). This may be indicative of the ability of MS to incorporate more milk fat into the cheese body than other coagulants. The cheese formed by the different coagulants had similar ash contents while lactose was higher in SA (0.57 %), PA (0.57 %) and LM (0.52 %) compared to MS (0.42 %). Casein content of cheese was highest in SA (11.80 %) and MS (11.80 %), and lowest in LM (11.08 %). The result showed that each of the coagulants have different capacities to concentrate different chemical components of the milk in cheese. Sensory properties of cheese precipitated by the different coagulants are presented in Table 2. The best scores in cheese colour were obtained by SA, MS, PA and LM (7.06 – 7.24) while the least colour score was obtained by MA (6.41). This was due to the slightly green colouration in LM cheese compared to other cheeses which were relatively white. The aroma of PA, MA and SA (6.18, 6.18, and 6.06 respectively) were judged to be the best while MS (4.76) was judged to be least in aroma scores. The taste and texture scores of cheese were judged highest in SA and PA and least in LM and MS by the panelists. The overall acceptability of the cheese which was expressed as the average score of all sensory parameters showed that acceptability of cheese in this study was in the order PA > SA > MA > LM > MS. Acceptability scores for PA and SA (6.62 and 6.59) were similar; MA and LM (5.78 and 5.15), similar; and MS, (4.94) the least. The coagulation time, pH and yield of cheese precipitated with different coagulants are presented in Table 3. There were significant ($p<0.05$) differences in coagulation time among the different coagulants. The shortest coagulation time was achieved with PA and the longest coagulation time was achieved with MS.

Presented in Table 3 are coagulation time, pH and yield of cheese precipitated with diverse extracts. The order of coagulation in this study was PA followed by SA, LM, MA, and MS, showing that PA and SA had faster precipitating attributes than other coagulants; LM and MA were medium while MS was slow. There were significant differences ($p < 0.05$) in pH of fresh cheese precipitated by different coagulants. The pH for SA and PA was similar and toward neutrality while MA and MS were slightly acidic, and LM acidic. This suggests that coagulation mechanism in SA and PA were enzymatic in nature while LM was due to acidic reactions. The pH value also suggests that the mode of precipitation in MA and MS is a combination of acidic and enzymatic actions (Ebing and Rutgers, 2006). It appears from the forgoing that enzymatic actions were quicker and more effective in precipitating milk for cheese than acidic reactions. The pH values reported in the present study are within the range reported by Gbadamosi (1994) for cheese precipitated with sodom apple, ascorbic acid and sweet orange juice. Cheese yield from milk precipitated with different coagulants varied significantly ($p < 0.05$) among treatments. Yield of fresh cheese varied from 23.41 % for SA to 42.04 % for MS. The order of the yield was SA > PA > MA > LM > MS, showing that SA was superior to other coagulants for economic cheese production. This may therefore, explain why it is preferred by indigenous cheese makers in Nigeria to other coagulants.

Weight change in cheese under refrigerated storage for 36 and 72 hours are presented in Table 4. There were significant differences ($p < 0.05$) in weight loss in cheese after refrigerated storage for 36 and 72 hrs post-production. At 36 hrs of storage the highest weight loss was observed in PA followed by LM, SA, MA and MS, showing that MS retained more of its body mass after 36 hrs while PA lost a significant proportion of its body mass.

Table 4: Weight change (g) in cheese during refrigerated storage

Refrigeration time	SA	PA	LM	MA	MS	SEM
36 hrs	0.56[b]	1.52[a]	0.69[b]	0.50[b]	0.43[b]	0.30
72 hrs	1.09[b]	1.99[a]	0.88[c]	0.82[c]	0.65[c]	0.33

Values with different superscripts within the same row are significantly different ($p < 0.05$). SA: sodom apple leaves extract; PA: pineapple fruit extract; LM: lime fruit extract; MA: mango fruit extract; MS: moringa seed extract

A similar trend was observed after 72 hrs of storage except that SA lost more of its body mass than LM during this storage period. The reason for this observation is not known but it is possible that PA, LM, SA and MA incorporated more moisture into their body mass during production which was lost by evaporation during storage.

CONCLUSION

Although sodom apple showed superiority to other coagulants for most of the parameters studied, our results indicated that cheese produced with pineapple juice had qualities that compared favourably well with sodom apple and could form a suitable alternative for this vegetable rennet in commercial cheese-making in Nigeria. Since other coagulants also formed good cheese, they could replace sodom apple juice in the production of fresh cheese when availability or access to sodom apple becomes limited.

CONFLICT OF INTEREST

Authors declare that no conflict of interest exist concerning this manuscript.

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