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Developing technology for a ginger-spiced cheese in Cameroon

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ABSTRACT

Objective: To determine how the incorporation of ginger powder as a spice in cheese would affect the physico-chemical and microbiological aspects of the product. *Methodology and results:* Fresh morning cow's milk, cheese starter culture and calf rennet were used to make cheese. Ginger powder was incorporated at three levels of concentration (0.25, 0.5, 0.75% w/w) and at various points in the cheese making process. Acid development and protein changes were determined by simple titration and Formol titration, respectively, with 0.1M NaOH. Cheese yield and dry matter as well as total colony counts of bacteria, yeasts and moulds were determined. Results indicated a regular pattern of protein losses in the whey, while acid development was too high (0.517%LA) where ginger was added after milk pasteurisation compared to other treatments. Yield ranged from 13.53 to 15.54 kg cheese per 100 kg milk and was best for the treatment with 0.5% (w/w) ginger, especially when the ginger was added before milk pasteurisation. There was no regular pattern for dry matter and bacteria count, though the bacteria count was highest (96.33 x 10^8 cfu/g) where ginger was added after milk pasteurisation. Colony counts of yeasts and moulds decreased with increase in ginger concentration. It was observed that milk and ginger powder do not mix well and would be difficult to manipulate in cheese making. *Conclusion and application of findings:* It is possible to produce ginger-spiced cheese without detrimental alterations of the microbiological and physico-chemical processes that occur during cheese making. However, it is best to add ginger powder in curd after salting, with least concentration being 0.5% (w/w) per wet cheese curd. These findings will contribute to the efforts of Research and Development Units of dairy industries that would like to produce cheese for consumers of spiced foods.

Key words: Bacteria, cheese, moulds, yeasts, *Zingiber officinale*

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INTRODUCTION

The processing of milk into cheese is not a popular indigenous technology in Cameroon (Kameni *et al*., 1999). However, in the past, there existed the Wum Cheese Co-operative Society in the North-West Region that produced and sold cheese in the early 1970s when the Germans established the Wum Area Development Authority (WADA) farm (Tambi, 1991). The departure of the Germans, inadequate mastery of cheese making technology and low demand for cheese led to the closure of

the Co-operative Society. Nevertheless, researchers have successfully adapted some cheese making procedures to local Cameroonian conditions (Kameni & Imélé, 1997; Mendi *et al*., 2000).

Cheese consumption is not yet very popular amongst Cameroonians. In a survey in Bamenda town the headquarters of the North-West Region, Vabi and Tambi (1995), observed that 85.3% of the population in the low-income, 76.9% in the medium-income and 59.4% in high-income levels did not consume cheese. The low consumption of cheese by Cameroonians could be attributed to several reasons amongst which may be unfamiliar cheese taste. This could be addressed through development of a technology to produce cheese of a taste that is similar to some local dishes, using ginger as a spice.

The main material for cheese making in Cameroon presently is fresh cow milk. The composition of fresh cow milk varies with several factors but is essentially proteins, lipids, carbohydrates, vitamins and minerals, all suspended in over 80% water. The major proteins in milk comprise of whey and casein which makes up about two thirds of all milk proteins. The caseins are of several fractions including the αs_1, αs_2, β and the κ-casein fractions. The caseins form complex compounds with calcium and phosphates known as micelles, which are surrounded by the κ-casein giving the proteins adequate protection against disruption. In cheese making, the enzymes added in the rennet, and those from culture microorganisms, disrupt this protein stability. The culture bacteria also ferment lactose producing lactic and other organic acids. Some milk fat may be hydrolysed by lipase, releasing fatty acids. This changes the interaction between milk components causing the precipitation of casein at the appropriate pH, usually about 4.5-5.0 to give the cheese curd. Acid development is very important in cheese making and determines the nature of the curd, hence the type or variety and yield of cheese (Dalgleish, 1987).

In this study, the effect of introducing ginger as a spice in cheese making on acid development, cheese yield and other biochemical processes that give cheese its unique characteristics, as well as the microflora and microbial load were investigated.

MATERIALS AND METHODS

Equipment: The equipment for cheese making in the laboratory consisted of a 20 litres capacity stainless steel pot, two 50 litres capacity aluminium pots, a perforated ladle that served as the cutting knife, cheesecloth, a food grade thermometer, locally fabricated cheese moulds and presses, and a gas heating source.

Ginger powder: One kilogram of fresh ginger (*Zingiber officinale*) rhizomes was purchased from the Bamenda Town Food Market and taken to the laboratory for processing into ginger powder. The rhizomes were washed to remove soil, peeled and washed again in clean water and sliced into thin pieces. Five hundred grams (500g) of the sliced ginger was heat-treated by adding 200 ml of clean water and steaming for 5–8 minutes in an aluminium pot, on the largest ring of a standard size kitchen gas cooker. Temperature attained by the ginger was 85–90 °C, at which a light brown colour was developed. The ginger was then dried in an oven (CARBOLITE 22265, FISON 77 WAY, THETFORD U.K.), at 60-64 ^{o}C for 18-20 h to a moisture content of 11.9–13.2 %. The moisture content was determined using a moisture balance (ADAM EQUIPMENT AMB 310, UK). A few slices of ginger weighing about 15g were placed and spread evenly on the weighing pan of the balance, a drying temperature of 102 ^{o}C was selected and the balance switched on. At steady conditions, the weight of the sample, drying time and moisture content in percentage were recorded. The dried ginger was ground into powder using an electric kitchen blender (National MX-T2GN china) and sieved through a metallic sieve of about 0.39 mm^2 pore-size.

Starter cultures: The cheese starter culture was a thermophilic multiple-species bacterial culture comprising of *Streptococcus thermophilus, Lactobacillus acidophilus* and *Bifidobacterium lactis*, produced by Danisco Niebull GmbH, Germany; and calf rennet of 95% Chymosin made by Natura Lab. AMREIN AG Sursee, was used as the coagulant.

Cheese production: Cheese was made in two trials in which ginger was incorporated at various points in the

cheese making process. Thirty litres of fresh morning milk were bought from the Fulani women who milk local Fulani cows (*Bos indicus*) and taken to the laboratory for immediate cheese making. In the first trial, the milk was weighed and divided into four lots of 7 kg each. The milk was put in different pots and pasteurised separately by heating in a water bath to 72 °C followed by rapid cooling to 32 °C before adding the starter culture. The ginger powder was added to milk 30 min after the addition of culture at the following rates: 0.0, 0.25, 0.50, and 0.75 % (w/w) of fresh milk in the different pots that served as cheese vats. The cheese making procedure then continued as outlined in Fig.1, with main stages for monitoring being: 1- Just before Renneting; 2- Cutting the curd; 3- Draining the whey and 4- Pressing. Thus, four blocks of cheese were obtained for the various ginger concentrations and the trial was carried out in triplicates.

In the second trial, also in triplicates, the cheese making procedure was as described above and outlined in Fig.1. However, the cheese was made in three lots using 7.0 kg of milk each with the ginger powder being incorporated at the rate of 0.5% (w/w) of fresh milk or wet cheese curd. The different treatments were as follows: Pot A = ginger was added before pasteurisation of milk; Pot B = ginger was added after pasteurisation, cooling and culturing of the milk; Pot C = ginger was added after draining of whey and addition of salt. The cheese was set to ripen in the refrigerator at 6-8 °C for two weeks. Three blocks of cheese were obtained.

Physico-chemical and microbiological characterisation

Protein content: Protein content of cheese milk and protein losses in whey were assayed by Formol titration. The method proposed by Pyne (1932) as described by Egan *et al*. (1981), was used but without addition of oxalate. The protein content of the milk or whey equivalent to N x 6.38 from the Kjeldahl method was obtained by this calculation: 1.95(a-b) % since addition of oxalate was omitted, *a* and *b* being the sample and blank titres, respectively. The titration was done in duplicates for each batch of cheese milk and for each cheese vat. Protein losses were monitored at; (i) just before renneting, (ii) cutting the curd, (iii) draining the whey, and (iv) pressing.

Titratable Acidity: This was determined as described by Egan *et al*. (1981).

Cheese yield: All the cheese blocks were weighed on a top loader electronic balance just after removal from pressing to get the fresh cheese weight. The cheese yield was calculated and expressed in Kg cheese per 100 kg milk.

Dry matter: The dry matter (DM) of the cheese samples was determined as described by Egan *et al*. (1981) where 3 g of cheese samples were weighed and placed in a dried dish that contained fine laboratory sand. A few drops of water were added and the sample spread evenly with the help of a flat-ended rod. The sample was dried on a boiling water bath and then drying was continued overnight in an oven at 100 °C.

Microbiological analysis: The method described by Harrigan and McCance (1976) was followed. The medium used for total colony counts of bacteria was Standard Plate Count Agar (A.P.H.A), while that for total colony count of yeasts and moulds was Potato Dextrose Agar (PDA) (Diagnostics Pasteur 3, FRANCE).

Ringer diluent was supplied in tablets form (BR 52, 100 tablets, OXOID; England) and quarter-strength ringer solution was prepared, dispensed into universal bottles and sterilised by autoclaving at 121 ^{o}C for 15 minutes. The work bench was swabbed with 70 % ethyl alcohol and Bunsen flames were lit to provide a sterile working environment. Plastic pipette tips of 1ml and small glassware had been sterilized by autoclaving at 121 °C for 20 minutes. Petri dishes were sterilised by heating in a vacuum oven at 120 °C for 3 hours and allowed to cool still wrapped or in their canisters to be removed just before use.

Ten (10) grams of cheese samples were aseptically weighed on an analytical balance and placed in sterile labelled stomacher bags and 90 millilitres of quarter-strength Ringer diluent aseptically added. The samples were blended in a Stomacher (Model 400 CIRCULATOR, SEWARD, ENGLAND) for 1min. Serial dilutions (10^{-1} to10^{-10}) of samples were prepared. Dilutions of 10^{-7}, 10^{-8}, 10^{-9} and 10^{-10}, were plated in duplicates, on plate count agar (PCA) and incubated at 30 ^{o}C for 72 hours for total bacteria count while dilutions of 10^{-4},10^{-5}, and 10^{-6} were plated in duplicates, on potato dextrose agar (PDA) and incubated at 22-24 °C for 5 days for total yeasts and moulds counts. The colonies were counted manually on an electric lit Gallenkamp colony counter, and only plates of between 30 and 300 colonies were counted.

Data were subjected to ANOVA using the STATA version 9.0 to compare means.

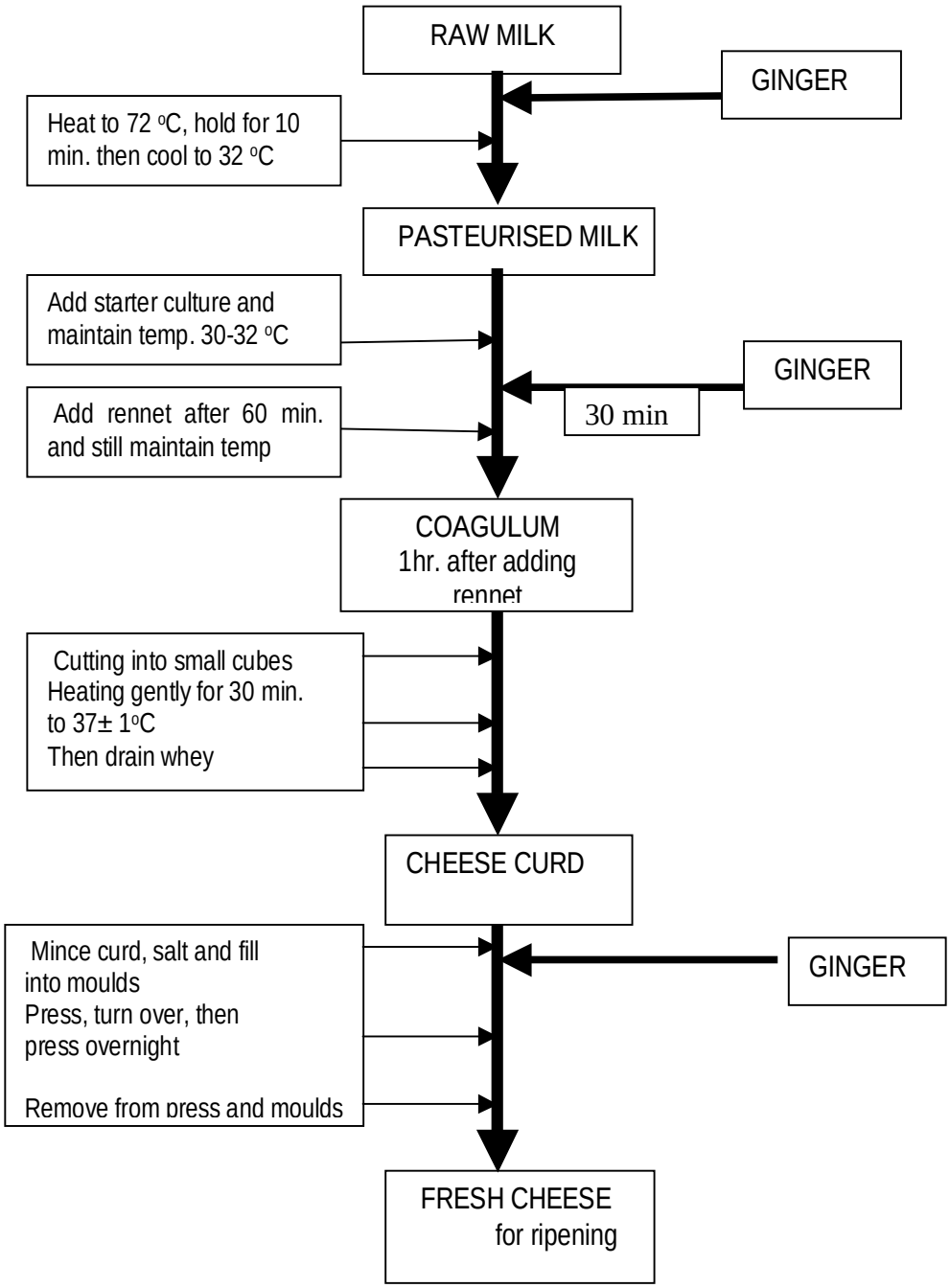

Figure 1: Flow diagram for the processing technology of a ginger- spiced cheese.

RESULTS AND DISCUSSION

The protein content of cheese milk and protein losses in whey were determined at the following points: (i) just before renneting, (ii) cutting the curd, (iii) draining the whey, and (iv) pressing. The protein content was 3.95% for samples of cultured milk without ginger (sample C) and 4% for cultured milk containing ginger (samples A and B) (Fig. 2)

Protein losses in whey were significantly different in cheese making stage 2 (cutting the curd) where treatment B (ginger added after pasteurization) had higher protein losses in the whey than A (ginger added before pasteurization) and C (ginger not added) ($P<0.05$). Protein levels in whey were significantly higher for treatment B than C in cheese making stage 3 (draining the whey). Protein levels were similar for all the treatments in cheese making stage 4 pressing (Fig. 2)

Table 1: Effects of incorporating ginger at different concentration levels in cheese production.

Parameter	Samples			
	A	B	C	D
Wet Cheese Yield (kg/100kg milk)	15.07±1.44	15.34±1.43	15.54±1.18	15.44± 0.50
Dry Matter %	49.3± 1.26	48.9± 3.14	49.1± 2.33	49.3 ±1.02
Wt. loss during ripening (%)	7.57± 6.22	6.68 ± 5.51	0.85 ± 0.48	0.41± 0.11
Total colony count. Bacteria ($x10^8$cfu/g)	21.33^{a} ± 3.51	35^{ab}±19.52	29.5^{ab}±19.96	44^{b}±7.81
Total colony count yeast and moulds ($x10^3$ cfu/g)	21.33^{a}±17.21	205^{b}±65.14	61.16^{ac}±45.28	55.67^{ac}±35.95

Samples A: no ginger; B: 0.25%; C: 0.5%; D: 0.75% ginger in milk; Means + SD (standard deviation values) for three determinations; None and same letter superscripts in the row are not significantly different ($P>0.05$); Different letter superscripts are significantly different ($P<0.05$).

Levels of nitrogen in whey during cheese making are indicative of proteolysis, leading to the estimation of losses in cheese yield (Emmons *et al*., 1991). However, the milk protein fraction involved in cheese making is the casein and more especially, the paracasein that makes up to 98.21% of cheese proteins (Emmons *et al*., 2003). Therefore, most of the proteins estimated in the whey (Fig. 2) would not have any significant effect on the protein content of the cheese.

Titratable acidity determined at pressing (stage 4) was significantly higher ($P<0.05$) than that for other cheese making stages. The acidity at stage 1 (just before renneting), was significantly higher than that at stage 3 (at draining). There were significantly higher ($P<0.05$) levels of titratable acidity in treatments containing ginger than in treatments without ginger at cheese making stages 2 (cutting the curd) and 4 (pressing). The treatment in which ginger was added after pasteurisation developed more acid compared to other treatments at all the cheese making stages (Fig 3) This observation indicates that if ginger added to milk does not undergo heat treatment, acid development would be enhanced, hence lower pH for optimum milk clotting. Naylor (1992) reported an increase in pH that led to adverse effect on milk clotting as large amounts of bicarbonates were added to milk.

Table 2: Effects of incorporating ginger at different points during cheese production.

Parameter	Samples		
	A	B	C
Wet Cheese Yield (kg/100kg milk)	13.7±1.02	14.3±0.57	13.5±1.32
Dry Matter %	49.8±3.17	52.8±4.13	50.1±1.04
Total colony count of Bacteria ($x10^8$cfu/g)	50.67^{a}±15.01	96.33^{b}±6.03	39.67^{ab}±35.95
Total colony count yeast and moulds ($x10^3$ cfu/g)	52±41.58	24±16.18	14.3±8.0

Means + SD (standard deviation values) for three determinations; None and same letter superscripts in the row are not significantly different ($P>0.05$); Different letter superscripts are significantly different ($P<0.05$); Samples A: 0.5% ginger in milk before pasteurisation; B: 0.5% in milk after pasteurisation; C: 0.5% in curd.

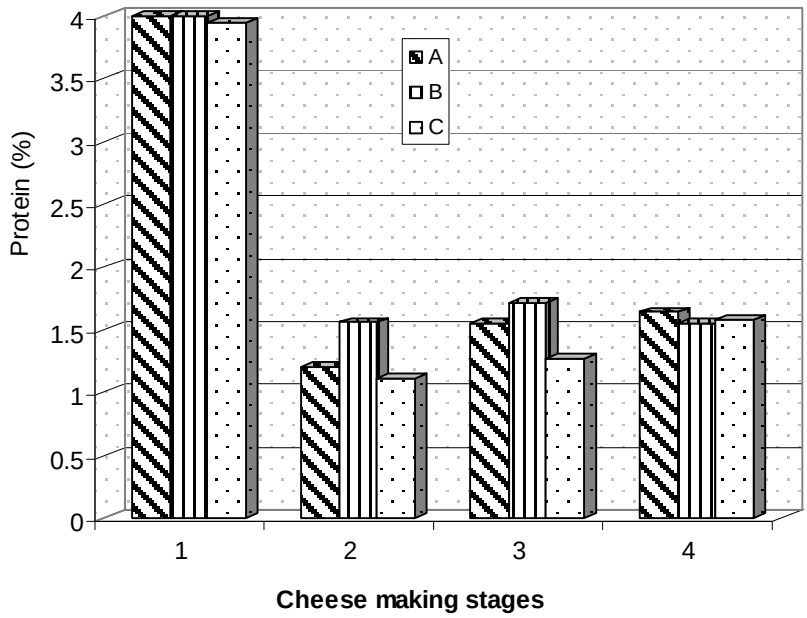

Figure 2: Protein changes during cheese production. Samples are A-Ginger added before pasteurisation; B -Ginger added after pasteurisation; C -No Ginger added; Cheese making stages are 1 -Just before Renneting; 2 -at Cutting; 3- at Draining; and 4 at Pressing.

The effects of incorporating ginger on cheese yield, dry matter, weight loss during ripening, total colony counts of bacteria and yeasts and moulds were determined (Tables 1 and 2). In the first trial, average cheese yield varied but with no significant difference ($P>0.05$) from 15.07 to 15.54 kg cheese per 100 kg milk for samples containing 0, 0.25, 0.5 or 0.75 % ginger (Table1). In the second trial, samples A, B and C (all containing 0.5 % ginger added at different points in milk and/or in curd) (Table 2), the average yields were 13.68, 14.3 and 13.53 kg cheese per 100 kg milk. Treatment B (ginger added after pasteurization), had highest acid development and also the highest yield (14.3 kg/100 kg milk) compared to A (ginger added before pasteurization) and C (no ginger added) (Table 2 and Fig. 3). This observation confirmed the important role of acid development during cheese making in terms of creating optimum conditions for milk clotting and curd firmness (Ernstrom & Wong, 1983). Cheese yields were best when 0.5% ginger was added in the milk after pasteurization.

Dry matter did not vary in any particular pattern and there were no significant differences ($P>0.05$) for all the treatments. Weight loss during ripening with increase in ginger concentration, decreased but not significantly ($P>0.05$). This observation suggests that the weight loss was not due to moisture loss only, but possibly due to other factors such as activities of microorganisms and enzymes that could hydrolyse fat, proteins, and lactose, producing volatile compounds that could escape from the cheese invisibly since the cheese was not vacuum packed (Jenness, 1982).

The total colony count of bacteria was lowest (21.33×10^8 cfu/g; Table 1) for cheese in which ginger was not incorporated and highest (96.33×10^8 cfu/g Table 2) where ginger powder was added after milk pasteurisation. There was a significant difference ($P<0.05$) in bacterial colony counts between the treatments. However, the counts of yeasts and moulds decreased significantly ($P<0.05$) with increased ginger concentration (205 to 55.67×10^3cfu/g) (Table 1). However, all the microbial counts were higher, probably as this was a semi-hard cheese, than those reported by *Kameni et al*. (2006) for Bafut cheese which is a hard cheese.

During cheese making, it was observed that ginger powder and milk did not mix well thus making the manipulation difficult. Therefore, in producing ginger-spiced cheese, it is recommended that the

ginger powder be added in the curd after salting. The best ginger powder concentration would be 0.5 % (w/w) of wet cheese curd.

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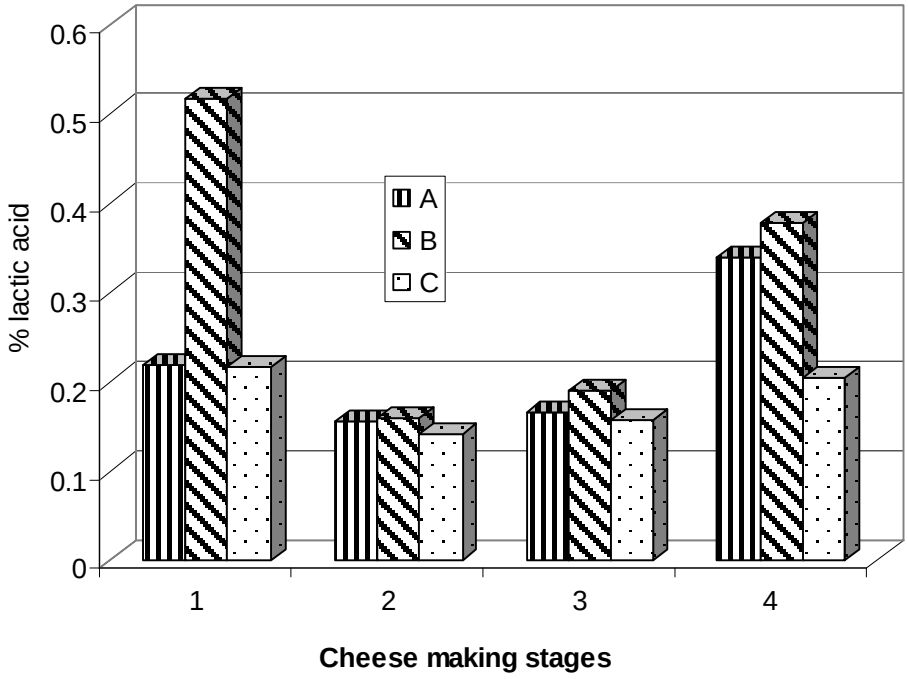

Figure 3: Acid development during cheese production. Samples were A -Ginger added before pasteurisation; B - Ginger added after pasteurisation; C -No Ginger added; Cheese making stages are 1 -Just before Renneting; 2 -at Cutting; 3 - at Draining; and 4 -at Pressing.

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