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**OPTIMIZATION OF THE EXTRACTION OF SOYMILK AND FORMULATION OF
SOFT CHEESE FROM COW MILK AND SOYMILK**

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ABSTRACT

As part of solution to the malnutrition problems in Sub-Saharan Regions in general and Cameroon in particular, especially that associated to proteins, extraction of soymilk and formulation of “Queen’s cheese” from a blend of soymilk and fresh cow milk was set as objectives of this work. With respect to these objectives, the study was carried out in Ngaoundéré in the Adamawa Region of Cameroon, from June to November 2012. Optimization of the extraction of soymilk from soy bean was carried out with water as extraction solvent. This was done by the use of a centre composite plan with mixing time and soy flour concentration as factors. The response considered was the concentration of total polyphenols. After the extraction of soymilk, Queen’s cheese was produced. The main results showed that optimum conditions of soymilk extraction are a mixing Time of 13.5 minutes and soy flour concentration of 72.77 g/L. Sensory evaluation showed that, sample B (90 % of cow milk and 10% of soymilk) was the best formulation as it had a 79.1% acceptance with respect to the others. Queen’s cheese is of acceptable microbial quality, hence safe for consumption. High functional Queen’s cheese produced from a blend of fresh cow milk and soymilk is appreciated by consumers when made with a low portion of soymilk.

Keywords: Cheese, Soymilk, Soybean, Milk, Extraction, Optimization

INTRODUCTION

Faced with the high incidence of malnutrition, particularly that linked to low protein intake in sub-Saharan Africa and Cameroon (23%) in particular, the need for increased protein intake from animal sources cannot be overemphasized. It is in this

perspective that cheese could be considered as a good food source of protein in our local diets. Cheese is a concentrated dairy product rich in proteins, lipids, carbohydrates and minerals especially calcium. Unfortunately, in Cameroon, the consumption level of cheese is low for several reasons. It is expensive and its taste is unappreciated by most of the population [1]. Meanwhile, the tendency could be reversed if cheese is produced locally. The adding of local ingredient can also contribute to improve the acceptability of cheese. In this way, soy bean is commonly used in babies' food formulation, production of yoghurt (soghurt) and animal feed. Soybean is cultivated in Cameroon and is the only plant protein source having an amino acid profile similar to red meat, egg and other animal proteins [2]. Besides its organoleptic properties, its proteins and isoflavones have been shown to have beneficial health effects with reference to reduction of chronic and degenerative diseases [3]. Using soy bean in the production of cheese could be a way of improving on the taste of cheese and eventually the consumption rate. The development of Queen's (soymilk/cow milk) cheese is as a contribution to the enhancement of protein intake leading to part of the solution of malnutrition in

Cameroon. The main objective of this work is to formulate soft cheese from cow milk and soymilk blend.

MATERIAL AND METHODS

Optimization of Soymilk Extraction

Soy Flour Production

Soy bean was bought from the Ngaoundere main market. After washing, drying and roasting (100°C during 15 minutes), soy bean was cooled (2hrs, 24°C) before milling and sieving (355mm).

Extraction of Soymilk

This was done by the use of a centre composite plan with mixing time and soy flour concentration as factors. Various masses of soy flour were measured (table 1), and mixed with heated tap water (45°C). Water volume, resting time, and mixing speed were fixed parameters while varying soy flour concentration and mixing time. The 10 different samples were filtered and the phenolic compounds in various samples were then measured individually by measuring the absorbance at 760nm.

Formulation of Queen's Cheese

Fresh cow milk sample was bought from Ngaoundéré Dairy Farm. Blends were formed as shown on table 2 with 12 samples and two controls.

Queen's cheese was then obtained according to the following diagram.

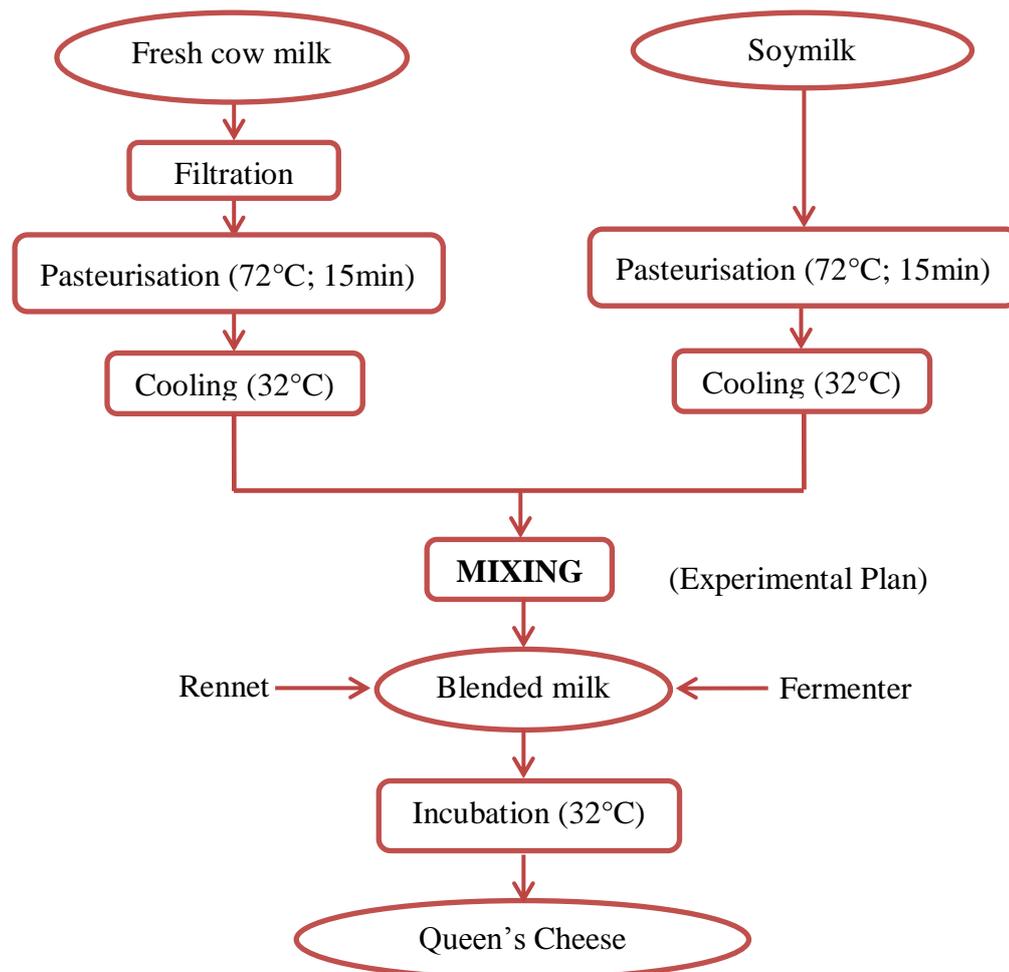


Figure 1: Flow Diagram for the Production of Queen's Cheese

Queen's cheese obtain was then liable to microbiological and physical analyses. The pH value was measured after 345 minutes. For the texture measurement, the different cheese samples were placed in a small cup and then mounted under texture analyzer with the following properties: speed = 2mm/s, distance = 10mm, trigger = 0,6g. The various formulated cheeses were also submitted for sensory evaluation in order to determine the preference and/or the acceptability of the product. The panel was made up of 32 persons.

RESULTS AND DISCUSSION

Extraction of Soymilk

From the 10 runs, the maximum concentration of total polyphenols was registered in run 5, while the minimum was in run 2 (table 3). But we are interested in conditions where total polyphenol is maximized. Hence, the mathematical model is a polynomial having two variables; X_1 , X_2 .

$$Y(X_1, X_2) = -0.817176 + 0.146157 * X_1 + 0.275336 * X_2 - 0.000586668 * X_1 X_1 - 0.00172952 * X_1 X_2 - 0.00172939 * X_2 X_2$$

X_1 = Mixing time, X_2 = Concentration of soy flour and $Y(X_1, X_2)$ representing the

mathematical model for total polyphenols.

The above model shows that the linear forms of both factors had a greater influence on the concentration of total polyphenols as they both contributed positively and over 98.5% to the model, while the quadratic forms and the interactive form of the factors were of very little significance to the experimental process.

Soy flour concentration and mixing time as individual factors greatly influenced the model unlike their interactive and quadratic forms of these factors. The effect of soy flour concentration is paramount as it positively influenced our model and has the highest coefficient in the model. Therefore, there exist a linear relationship between soy flour concentration and the concentration of total polyphenols. Increase in soy flour concentration, increases the concentration of total polyphenols. Mixing time also influenced our model to an extent, having a positive coefficient as soy flour concentration, but its effect is not as felt as that of soy flour concentration as its value was smaller as compared to that of the concentration of soy flour. Hence, there exist a threshold time of reaction between the soy particles and extraction solvent, above which the effect of mixing time on the model will not be felt for every given concentration of soy flour. This threshold

time lies between 12.5 and 17.5 minutes. The joined effects and the individual quadratic forms of these factors were insignificant on the model as they contributed negatively to it. The plot on figure 2 shows that the total polyphenols of extract increased with increasing concentration of soy flour and mixing time and was fairly constant between a range of mixing time (12.5 up to 17.5 minutes). The effect of mixing time on the model might have been different but for the fact that a minimum resting time of 5 minutes before the actual mixing time with the homogenizer was observed. These results show that the role of soy flour concentration in the extraction of soymilk is a more determining factor in optimizing total polyphenol concentration as it has a 64.70% contribution in the entire optimization process. Though the contribution of the mixing time in extracting soymilk appears to be facultative (33.35%), a minimum contact time between the soy flour and the extraction solvent (water) will be required for the gelation of the flour and maximize nutrient extracts, as these nutrients might be hydro-soluble. In this case optimized conditions were as follows: mixing time: 13,5 minutes and soy flour concentration: 72,77 g/L.

Fabrication of Queen's Cheese

Coagulation Time

It was observed that the coagulation time increases with increase in concentration of soymilk (**Figure 3**). This can be explained by the absence of casein in the soy milk. Since acidic and enzymatic hydrolysis are both effective in the presence of casein, the coagulating effect can be reduced if absent in a pure soymilk sample. Increasing the concentration of soymilk further dilutes casein in the blend thereby increasing both the reaction and contact time between the molecule and its substrate.

pH

Cow milk cheese sample had the lowest pH value (5) with respect to the rest of the other samples, while soymilk cheese sample had the highest pH value after measurement of lactoserum extracted from the various soft cheese samples (**Figure 4**). The increase in pH of the lactoserum from various blends with increase in the concentration of soymilk after inoculation of the fermenter and rennet could be due to the fact that the lactic fermenter easily and readily digests lactose to produce lactic acid than the soymilk sugars (sucrose, raffinose, and stachyose). The lactic acid production which decreases as the soymilk concentration increases, results in the fall of the pH value in the pure cow milk sample where lactose concentration is high. These results are not similar to those reported by Owusu-

Kwarteng *et al.* (2010) [4] who found that the addition of soy milk increases the production of lactic acid during the production of “Hausa koko”, a Ghanaian fermented porridge.

Texture

The texture of the cheese treatments was evaluated by the estimation of its elasticity which decreases with increase in soymilk levels in the cheese (**Figure 5**). The presence of soymilk in cheese disrupted the normal texturisation during production process [5]. The pure cow milk cheese sample had the maximum penetration force, while it decreases linearly as soymilk concentration increases in the cheese sample. Meenakshi and Verma (1994) [6] also found that body texture score of soy cheese decreased with increase in proportion of soy milk in the blend. Since in the pure cow milk cheese sample, the concentration of casein is high, after their destruction during acidification to reach the iso-electric pH, they curdled. These cheese' curdles bind tiedly amongst themselves, than when diluted with the soymilk which do not contain casein. Also, disulphide linkages exist in cow milk because it contains sulphur containing amino acids.

Microbial Characteristics

Amongst the five microorganisms searched for in the cheese sample, *Salmonella spp.* and *Clostridium perfringens* were

completely absent (figure 6). While *Staphylococcus aureus* (3.0×10^2 CFU/g), *Escherichia coli* (5.2×10^2 CFU/g) and yeast/moulds (5.2×10^2 CFU/g) were found on soymilk cheese sample. But, according to the 2073/2005/CE, Queen's cheese sample was of acceptable microbial quality; hence fit for human consumption.

Sensory Evaluation

The fresh cheese prepared from soymilk blend having 10 % of soy flour and 90 % of cow milk was of good quality in respect of sensory characteristics such as color, taste, flavor and overall acceptability (figure 7). The reason for gradual reduction in quality of the product from various samples could be due to the quantity of milk used for the

preparation of Soymilk cheese. The result of this study are similar to those reported by [7] who found that frozen desserts especially ice cream prepared from soymilk blend having 20 g of soy flour and 80 g of skim milk, was of good quality in respect of sensory characteristics such as color, taste, flavor and overall acceptability. This result is also in accordance with [6], who found that the organoleptic characteristics of cheese made from various cows and soya milk are directly related to the proportion of soy milk in the blend. Also for those authors, cow's milk can be replaced to the extent of 15 % with soy milk without affecting the sensory characteristics of cheese.

Table 1: Natural Values of Design Factors for the Extraction of Soymilk

Runs	Mixing Time (min)	[Soy Flour] (g/L)
1	23	50
2	12.5	0.5
3	2	50
4	20	15
5	5	85
6	5	15
7	12.5	99.5
8	20	85
9	12.5	50
10	12.5	50

Table 2: Mixture Designs for the Formulation of Cow & Soymilk Cheese

Runs	Milk (%)	Soy milk (%)
1	60	40
2	90	10
3	75	25
4	90	10
5	75	25
6	60	40
7	90	10
8	75	25
9	60	40
10	90	10
11	75	25
12	60	40
13	100	0
b14	0	100

Table 3: Responses Obtained by the Application of the Central Composite Design

Runs	Mixing Time (mins)	[SoyFlour] (g/L)	[polyphenols] (mg/L) Obs.	[polyphenols] (mg/L) Theo	Diff
1	23.1	50	9.513	9.69195	0.17895
2	12.5	0.5	0.433	1.04518	0.61218
3	1.9	50	8.299	8.73705	0.43805
4	20	15	5.525	5.09337	-0.43163
5	5	85	10.258	10.0726	-0.18540
6	5	15	4.125	3.51016	-0.61484
7	12.5	99.5	9.037	9.04182	0.00480
8	20	85	9.842	9.83984	-0.00210
9	12.5	50	9.338	9.28050	-0.05750
10	12.5	50	9.223	9.28050	0.05750

$$R^2 = 0.986869, AAD = 3.969 \cdot 10^{-8}$$

Estimated Response Surface

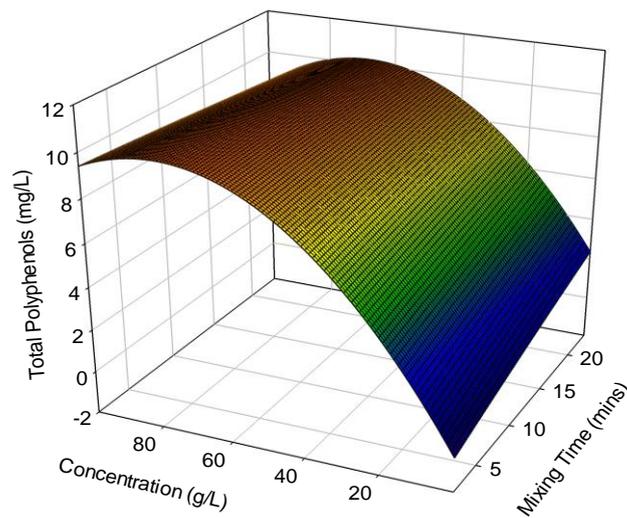


Figure 2: Variation of Mixing Time and Soy Flour Concentration As A Function of Total Polyphenols Concentration

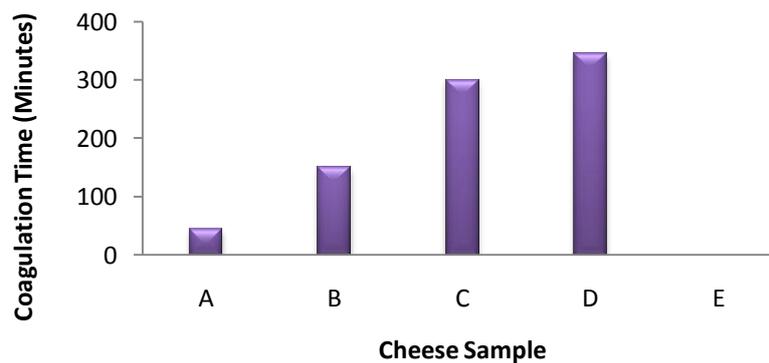


Figure 3: Evolution of coagulation time as a function of soymilk concentration in cheese.

A = 0% of soymilk, B = 10% of soymilk, C = 25% of soymilk, D = 40% of Soymilk

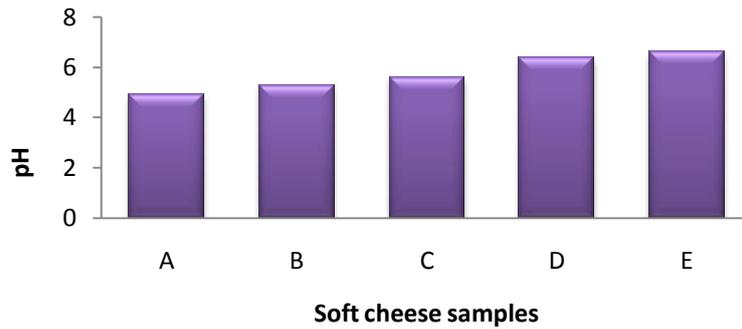


Figure 4: Evolution of pH as a Function of Soymilk Concentration in Cheese
 A = 0% of Soymilk, B = 10% of Soymilk, C = 25% of Soymilk, D = 40% of Soymilk

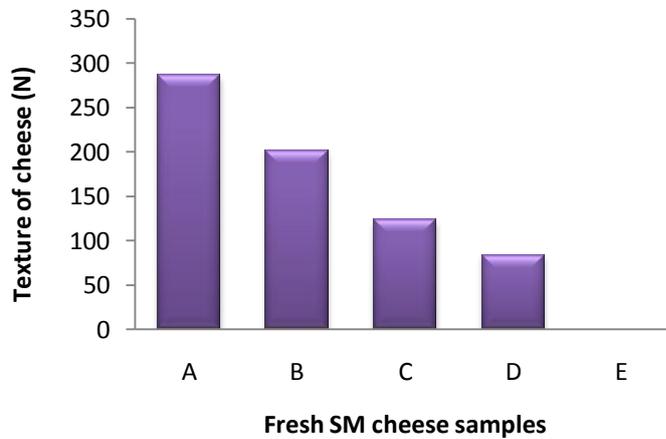


Figure 5: Variation of Cheese Texture as a Function of Soymilk Concentration
 A = 0% of soymilk, B = 10% of soymilk, C = 25% of soymilk, D = 40% of soymilk

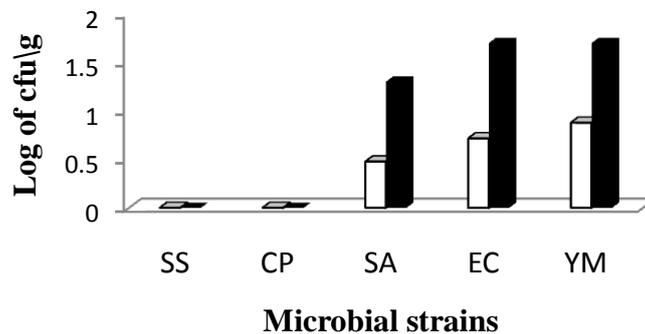


Figure 6: Microbiological Control of the Queen's Cheese

NOTE: ■ Standard microbial load of soft cheese; □ Microbial load of Queen's cheese; SS = *Salmonella* spp, CP = *Clostridium perfringens*, SA = *Staphylococcus aureus*, YM = yeast and moulds

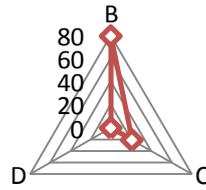


Figure 7: Sensory Evaluation of the Different Cheese Samples as a Function of Preference.

B = 10% of soymilk, C = 25% of soymilk, D = 40% of soymilk

CONCLUSION

A high functional Queen's cheese was produced from a blend of soymilk and fresh cow milk. The optimum conditions of soymilk extraction are a mixing Time of 13.5 minutes and soy flour concentration of 72.77 g/L. Sensory evaluation showed that, sample B (90 % of cow milk and 10% of soymilk) was the best formulation as it had a 79.1% acceptance with respect to the others. Queen's cheese is of acceptable microbial quality, hence safe for consumption. High functional Queen's cheese produced from a blend of fresh cow milk and soymilk is appreciated by consumers when made with a low portion of soymilk.

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