THE EFFECTS OF PRODUCTION PARAMETERS ON THE YIELD OF LOCAL CHEESE PRODUCED FROM COW MILK

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Abstract

Traditional cheese making was modernized using laboratory equipment under controlled production parameters in order to see their effects on the yield of cheese and the whey obtained from fresh cow milk. The three major parameters investigated were cooking temperature, coagulant concentration and cooking time. The temperature was varied between 40 to 80 ^{O}C with a step change of 10 ^{O}C at constant coagulant concentration and cooking time while the cooking time and coagulant concentration were varied between 10 to 50 minutes and 5 to 25 g/100ml H_2O with step changes of 10 minutes and 5g respectively. The results showed that the yield of cheese which is the primary product reacts to variation of the three tested parameters with significant increase in yield of 32.5 to 44.5g between the temperatures of 40 to 60 ^{O}C while that of coagulant concentration was observed between 5-15 g/100 ml H_2O with a corresponding increase in yield of 37.2-54.81g. Conversely, the lowest cooking time of 10 minutes gave the highest yield of 62.12g. In all cases, the yields of whey were inversely proportional to those of the cheese. The final result of this investigation have revealed that the yield of local cheese can be significantly improved by regulating the production parameters with the best parameters being 60 ^{O}C cooking temperature, 15 g/100 ml H_2O coagulant concentration and 10 minutes cooking time with the best yield of 62.12g cheese and 114 ml whey from 180 ml fresh cow milk.

Key words: *Local cheese, Whey, Cow milk, Coagulant and production parameters*

Introduction

In the early days, production of cheese in the America was an art. When it became necessary to produce larger quantity with considerable quality, the application of science and technology came into play. The high demand for cheese could not be met through traditional cheese making and that led to the

provision of cheese factory system. Cheese quality depends on the milk contents; as such the nature of the milk source and their locations globally affects final cheese quality (Johnson, 2017).

The economy of Fulani community of the middle belt province of Northern Nigeria relies essentially on animal breeding, with population of cattle of about 1.5 million and milk production estimated at 25,000 liters per day (Johnson, 2017). The milk obtained is either taken raw or concerted to the fermented form of milk known locally as *Nono* and *Kindirmou* which are generally associated with short shelf-life (Banville, *et al*., 2013). The conversion of cow milk to cheese which is a product that is much richer in proteins, is advantageous in the sense that it has a longer shelf life and easier to transport. Cheese is an important product that preserves the vital nutrient in milk and it serves as source of income for several individuals in Africa (Ozturk*et al*., 2015). The quantity of cheese manufactured in Africa is minimal when compared with the quantities manufactured in Europe and North America. More often than not production of cheese in Africa is usually on a minor scale in the farm. In Nigeria, the production is not scientifically done but rather based on traditional method inherited by children from their parents (Ozturk*et al*., 2013). The final products from such methods are of variable quality due to non-regular quantity of ingredients and haphazard methods of production using local facilities and the juice extract from *Calotropis procera*as a coagulant (Johnson, 2017). Local white cheese (*Wara*) is customarily sold on the day of production. This is due to the fact that it contains high moisture content of about 65 % a factor that encourages microbial action. The high moisture content results in higher yield and a shorter shelf life (Moynihan et al., 2016).The shelf life of cheese can be improved through three basic actions which involves; refrigeration, use of commercial starters, and the utilization of pasteurized milk as raw material for cheese production (Silva Castro and Furtado, 2000).

The production of cheese is accompanied by large quantities of whey which is usually discarded as by product by the Fulani due to the fact that it causes running stomach due to it'shigh bacterial contents. This whey essentially comprises of lactose, water-soluble proteins like lacto-globuline and α-lactalbumine, mineral salts and vitamins. These components present a high nutritive value to the whey (Jervis *et al*., 2012; Croissant et al., 2009).

Several methods have been proposed on the pasteurization and preservation of whey (Emmons and Modler. 2010; Johnson, 2001; Johnson, 2014;Domingues *etal*., 2001; Ferrari *etal*., 2001) though their application under tropical conditions appears difficult considering the complexity and costs of equipment involved, as well as the need for numerous purification stages of the final products. As concerns local cheese production, there is scanty literature on techniques of its improvement (Latorre*et al*., 2010) as opposed to those for yoghurt, incorporation of the latter into other preparations (Panesar, 2011; Sharma *et al*, 2012;Shori, 2015; Tamime and Robinson 2000; Al-Zoreky and Al-Otaibi 2015), or on the study of profitability of milk production per cow (Ajai*et al.*, 2012; Chang, 2003).

This research will presents a simple improved technique for producing local cheese from cow milk using *Calotropis procera* plant extract as coagulant and the recovery of whey under controlled production parameters.

Materials and Methods

Materials

The raw cow milk was purchased from Alhaji bokolori cattle range in Emi gubagi village in Gbako local government area of Niger state Nigeria while *Calotropis Procera* plant leaves were collected from the bush.

Methodology

1. Determination of the Effect of Boiling Temperature on the Yield of Cheese and Whey

180 ml of fresh cow milk was placed in a 250 ml beaker. The beaker and its content were transferred to a hot plate operating at $40^{O}C$ for 30 minutes. 30 ml of 5 g/100ml H_2O of calotropis procera extract was added to the warm milk and the boiling temperature maintained at 40 ^{0}C. The mixture was continuously stirred at this temperature for a period of 10 minutes after which it was removed from the heating source and allowed to cool. The curd and Whey are poured into filtration apparatus serving as a filter and a mold. The whey (filtrate) was collected, the volume measured. The final curd sample (residue or cheese) was weighed. The experiment was repeated using boiling temperature of 50, 60, 70, and $80^{O}C$.

2. Determination of the effect of concentration of Coagulant on the yield of Cheese and Whey

The procedure in 1 above was repeated by fixing the boiling temperature at the value that gave the optimal yield and the concentration of *calotropis procera* extract (coagulant) was varied using 10, 15, 20, and 25 g/100 ml H_2O.

3. Determination of the effect of cooking time on the yield of Cheese and Whey

The process in 1 above was again repeated by fixing the boiling temperature and the concentration of coagulant at optimal values and varying the boiling time with values of, 20, 30 40 and 50 minutes.

Result and Discussions

Effect of temperature on the yield of cheese and whey

The cooking temperature of cheese was varied from 40^{o}C to 80^{o}C in other to investigates it's effects on the yield of both cheese and whey. The results obtained are presented in figures 1(a) and 1(b) respectively.

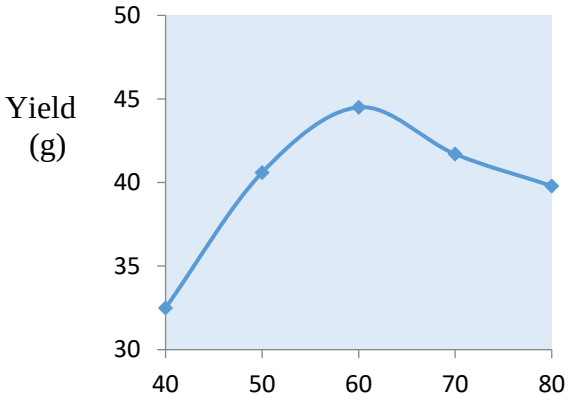

Figure 1(a): The effect of cooking temperature on the yield of Cheese

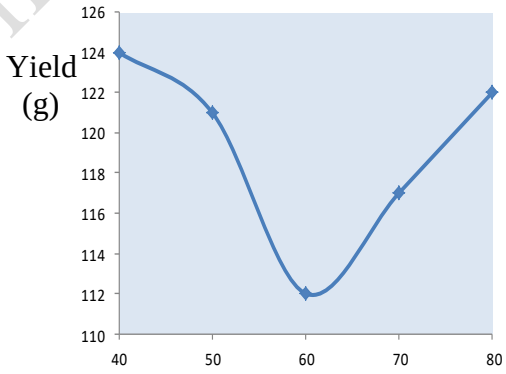

Figure 1(b): The effect of cooking temperature on the yield of Whey

The results of figure 1(a) showed that between the cooking temperatures of 40-60^{O}C, the yield of cheese increases steadily from 32.5 to 44.5g respectively. On the other hand as revealed by figure 1(b) the volume of whey obtained decreases from 124ml to 112ml. The reason for this is because more volume of milk is required for increase in the yield of cheese obtained. Since the whey is the

remnant liquid obtained after the cheese is formed, therefore more volume of whey is expected for low yield of cheese. From the temperature of 70 ^{O}C to 80 ^{O}C the yield of cheese declined from 41.7g to 39.8g respectively. This scenario could be as a result of higher activation energy of the reaction greater than the heat of formation of cheese and subsequently leads to bond breakage after formation, a reason for decrease in yield at temperatures beyond 60 ^{O}C.
This has proved the reason why the local Fulani women used smoldering fire instead of heavy flame for heating during cheese production. Going by these results, the boiling temperature of 60 ^{O}C can be selected as the optimum boiling temperature for local cheese production.

Effect of Concentration of Coagulant on the Yield of Cheese and Whey

The effect of concentration of *calotropies procera* plant on the yield and quantity of cheese and whey was investigated by varying the concentration using 5, 10, 15, 20, and 25g/100ml H_2O, 30 ml of each was added to 180 ml fresh milk per run at a fixed temperature of 60 ^{O}C.

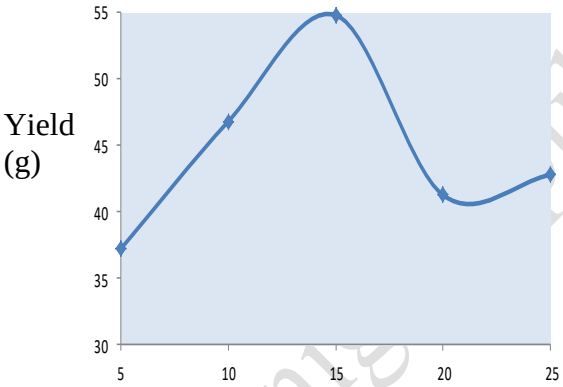

Figure 2(a): The effect of Concentrationof coagulant on the yield of Cheese

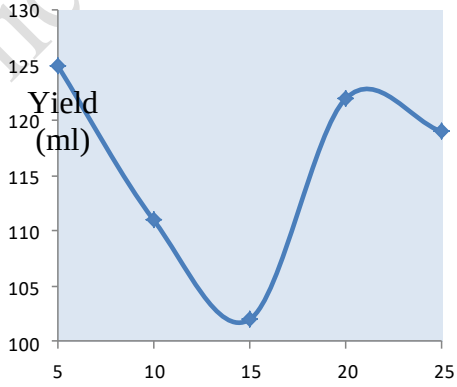

Figure 2(b): The effect of Concentrationof coagulant on the yield of Whey

The result in figure 2(a) showed that as the concentration of the coagulant is increased from 5-15g/100 ml H_2O; a significant increase in the yield of cheese was recorded with a value range of 37.2-54.81g respectively. At higher concentrations of 20 and 25 g/100 ml H_2O, the yield declined with numerical values of 41.25g and 42.78 g respectively. However, from figure 2(b) the yield of whey decreases within the same range of concentration of coagulant with a

value range of 125-102ml. This is expected because as more liquid milk are converted to cheese at higher yields the lesser the reminant whey. The whey volume also increases with value of 122ml and 119ml at lower cheese yields of 41.25g and 42.78g respectively. These results therefore suggest that the coagulant concentration of 15g/100 ml H_2O can be chosen as more appropriate for local cheese production.

Effect of Cooking time on the yield of cheese and whey

The effect of Cooking time on the yield of cheese and whey was investigated in order to ascertain the time at which maximum yield of cheese (which is the major product) is obtained and also see how much whey is obtainable at that particular time. The investigations were carried out at varying cooking (reaction) time of 10 – 50 minutes with a step change of 10 minutes at fixed boiling temperature and coagulant concentration of 60 ^{O}C and 15g/100 ml H_2O.

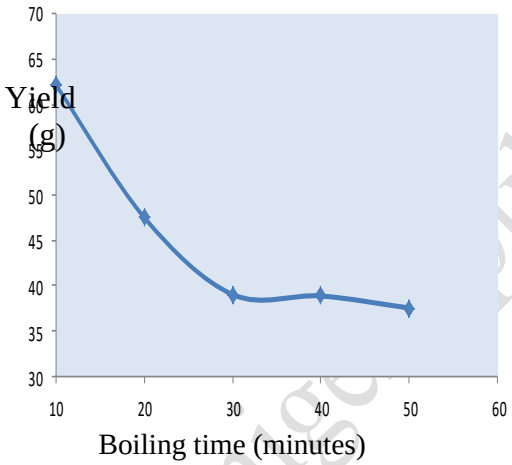

Figure 3(a): The effect of boiling time on the yield of Cheese

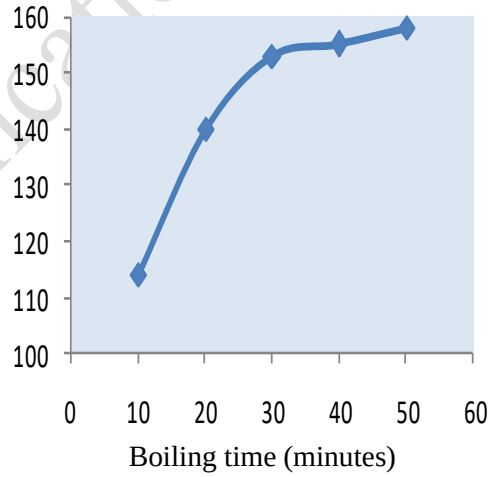

Figure 3(b): The effect of boiling time on the yield of Whey

From figure 3(a), it is clearly seen that increase in boiling time beyond 10 min does not favour the yield of cheese but rather favour the yield of whey as revealed by figure 3(b). The highest yield of cheese of 62.12g was recorded at a boiling time of 10minutes. The corresponding yield of whey at this time was 114ml. The lowest yield of cheese was recorded at the highest boiling time of 50 minutes which is the time at which the highest yield of whey of 158ml was obtained. The reason for this is because as the reaction proceeds the

concentration of the reactants that is the raw milk decreases due to coagulation and as soon as the milk is used up, the energy within the reaction medium accumulate with time and as the heat energy exceeds the heat of formation of cheese it results in the breakage of existing bonds being the cause of reduction of yield with time.

Conclusion

The yield of local cheese produced from cow milk was improved through production under regulated parameters. The three major parameters that affects the yield which includes, cooking temperature, coagulant concentration and cooking time were put to test and the results obtained suggests that the best parameters at which local cheese can be produced are: temperature of 60 ^{O}C, coagulant concentration of 15 g/100 ml H_2O and a cooking time of 10 minutes. The final yield of cheese and whey from 180 ml of fresh cow milk were 62.12g and 114 ml respectively.

Recommendations

- Cheese and whey drink production from other mammalian animals should also be investigated and compared with one obtained from cow milk.
- The shelf life extension of cheese and whey drink besides refrigeration should be extensively investigated.
- Cheese production from mixture of milk of plant and animal origins should be tested and compared with the one from animal only to see whether a high breed cheese is obtainable

References

Ajai, A. I., Ochigbo, S. S., Ndamitoso, M. M., &Ola, O. J. (2012). Proximate and mineral composition of different raw cow's milk in Minna. *European journal of applied engineering andscientific research,1,* 23-29.

Al-Zoreky, N. S. & Al-Otaibi, M. M. (2015). Suitabilityof camel milk for making yogurt, *Journal of Food Science And Biotechnology*, 24 (2), 601-606. doi:10.1007/s10068-015-0078-z

Barinotto M.E.P and Benedet H.D. (2000). Unicellular protein production from cheese whey by
Lactobacillus bulgaricus and streptococcus. Revista do Instituto de Laticínios Cândido Tostes 54: 126-36.

Banville, V., P. Morin, Pouliot, Y. and Britten, M. (2013). Physical properties of pizza

Mozzarella cheese manufactured under different cheese-making conditions.*J. Dairy Sci.* 96:4804–4815.

Chang, S. K. C. (2003). *Protein Analysis in FoodAnalysis*. 3rd edition, Kleurer Acesdenine PlenumPublishers, New York, 131-142.

Croissant, A. E., E. J. Kang, Campbell, R. E., Bastian, E. and Drake, M. A.(2009). The effect of bleaching agent on the flavor of liquid whey and whey protein concentrate. *J. Dairy Sci.* 92:5917–5927.

Emmons, D. B., and Modler, H. W. (2010). Invited review: A commentaryon the predictive cheese yield formulas. *J. Dairy Sci.* 93:5517–5537.

Jervis, S., Campbell, R., Wojciechowski, K. L., Foegeding, E. A., Drake, M. A. and Barbano D. M. (2012). Effect of bleaching whey on sensory and functional properties of 80% whey protein concentrate. *J. Dairy Sci*. 95:2848–2862.

Johnson, M. E. (2014). *Mesophilic and thermophilic cultures used intraditional cheesemaking*. Pages 73-94 in Cheese and Microbes. C. W. Donnelly, ed. American Society for Microbiology Press, Washington, DC.

Johnson, M. E., Chen, C. M. and Jaeggi, J. J. (2001). Effect of rennetcoagulation time on composition, yield, and quality of reduced-fat Cheddar cheese. *J. Dairy Sci*. 84:1027–1033.

Johnson M. E. (2017). A 100-Year Review*:* Cheese production and quality. *J. Dairy Sci.* 100:9952–9965

Latorre, A. A., Van Kessel, J. S., Karns, J. S., Zurakowski, M. J., Pradhan, A. K., Boor, K. J.,Jayarao, B. M., Houser, B. A., Daugherty C. S., and Schukken, Y. H. (2010). Biofilm in milking equipment on a dairy farm as a potential source of bulk tank milk contamination with*Listeria monocytogenes*. *J. Dairy Sci*. 93:2792–2802

Moynihan, A. C., Govindasamy-Lucey, S., Molitor, M., Jaeggi, J. J., Johnson, M.E., McSweeney, P. L. H. and Lucey, J. A. (2016). Effect of standardizing the lactose contentof cheese milk on the properties of low-moisture, part skim Mozzarella cheese. *J. Dairy Sci*.99:7791–7802.

Ozturk, M., Govindasamy–Lucey, S., Jaeggi, J. J., Houck, K., Johnson, M. E. and Lucey, J. A. (2013). Effect of various high-pressure treatments on the properties of reduced-fat Cheddar cheese. *J.Dairy Sci*. 96:6792–6806.

Ozturk, M., Govindasamy-Lucey, S., Jaeggi, J. J., Johnson, M. E. and Lucey, J. A. (2015). Low sodium Cheddar cheese: Effect of fortification of cheese milk with ultrafiltration Renate and high-hydrostatic pressure treatment of cheese. *J. Dairy Sci*. 98:6713–6726.

Panesar, P. S. (2011). Fermented Diary products: starter cultures and potential nutritional benefits. *Food and Nutrition Sciences, 2*(1), 47-51.

Sharma, R., Sanodiya, B. S., Bagrodia, D., Pandey,M., Sharma, A., &Bisen, P. S. (2012). Efficacy and potential of lactic acid bacteria modulating human health.,*International Journal ofPharmaceutical and Biology Sciences, 3*(4),935-948.

Shori, A. B. (2015). Camel milk as a potential therapy for controlling diabetes and its complications: a review of in vivo studies. J. Food and Drug Analysis, 23 (4), 609-618. doi:10.1016/j.jfda.2015.02.007

Silva Castro, C. and Furtado, M. M. (2000). Raw milk and whey starter in the production of Provolone cheese. Revista do Instituto de LaticíniosCândidoTostes 54: 98-104.

Tamime, A. Y. & Robinson, R. K. (2000).*Yoghurt science and technology* (2nd ed.)Boca Raton, USA: Wood head Publishing Ltd and CRC Press LLC.