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PROCESSING OF "KOSSAM" AN AFRICAN SOUR FERMENTED MILK BEVERAGE FROM NORTHERN CAMEROON

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Abstract
"Kossam" is a set of milk based beverage from northern Cameroon presenting great symbolic and social values for local population. They have high economic value for women as most important source of income for the family in rural area. In order to ameliorate process production with the view of industrialization some of their physicochemical properties needed to be standardize. In this line, the process productions of "Kossam" were carried out in order to identify critical points and eventually standardize the production process. To do this a cross-sectional and descriptive study including qualitative and quantitative survey followed by laboratory scale production were conducted. Different products were given to a panel, for sensory analysis and were used to access and compare physicochemical characteristics of artisanal and laboratory "Kossam".
The main identify Kossam product were: "mbiraadam" which stand whole milk, "kindirmou" indicating heated, concentrated and fermented "mbiraadam", and "pendidam" derived from skimmed heated and fermented "mbiraadam". Major steps identified for "Kossam" process production were mainly filtering leading to "mbiraadam", heating in smoked clays, cooling followed by natural fermentation leading to "kindirmou". The "mbiraadam" can also be skimmed before being heated and fermented to give "pendidam". Physico-chemical properties such as pH, total titrable acidity, as well as some rheological properties were screened. A standard flow diagram were proposed for "kossam production and sensory test were used to compare samples

Keywords: milk, mbiradam, pendidam, kindirmou, kossam, fermentation, Africa

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1. INTRODUCTION

Milk plays an important role in the Fulani tribe of northern Cameroon (Essomba *et al.,* 2002). Beyond the symbolic and social aspects, it has a high economic status for women because it is their most important source of income (Kuhn, 1984).

Despite the importance of these artisanal fermented milk beverages, some drawbacks limit their use both at nutritional and technological levels. These drawback include the high acidity due to uncontrolled fermentation process (Bromberger, 2004), their high perishability, poor hygienic quality and short shelf life (Younus *et al.,* 2002; Kaktcham, *et al.,* 2012).

Their production processes are still artisanal and not yet describe and standardizes (Shalo, and Hansen, 1973; Gaou., & Ticktin, 2009). Add to these, the consumption of fermented milk like yoghurts in developed countries has increased tremendously in the last 10 years owing to the ability of dairy industries to meet the challenges of producing different brands of fermented milk products with variable consumer appeals in constant competition with carbonated drinks (Trap *et al.,* 1993; Karagul-Yuceer *et al.,* 1999; Deis, 2000).

To tackle drawbacks which limit the use of artisanal fermented African milk and ameliorate their process production in order to face the new milk market and technological challenges of developed countries, this paper aims at carrying out investigations to describe the artisanal process production of "Kossam" in order to identify critical points and standardize production process.

Eventually to propose from this, new flow sheet production process which can be used at industrial level to standardize all "Kossam" production.

2. MATERIAL AND METHODS

Data collection on artisanal "Kossam" process production

Ethnographic methods as described by Schensul (1999) associated with focused group discussion method (Kumar, 1987) were used for data collection on the artisanal "Kossam" process production from the field. The sample size and localization of groups were clustered according to Weras (2002) clustering method, within northern regions of Cameroon namely, Adamaoua, North and Farth North.

Industrial process production design and laboratory preparation of "Kossam"

Industrial process design for "Kossam production" was set up as describe by Douglas (1988) using artisanal process production as based model. Few interviewed women during focus groups discussions were called to assist us in preparing "Kossam" according to the developed flow sheet, based on their interviews during focus group discussion. During this laboratory preparation, some steps were harmonized and corrected according to their observations.

Raw material for laboratory scale production

Raw milk was collected from the field directly from cows. Artisanal starter were collected from "bororo womens" from Adamaoua in the form of curd milk.

Sensory attributes

"Artisanal kossam", "laboratory produced kossam" and commercial yoghurt purchased from local market, were presented to a panel of experienced tasters regular yoghurt users and university students. The sensory analysis procedure suggested by Rivella (1987) was used. Each taster was given an evaluation form for each of the fermented milk samples. The form included four sensory attributes: taste, aroma, color, acidity and overall acceptability (harmony). Panelists were asked to assess the samples in terms of the listed attributes using a nine-point hedonic scale with 9 representing like extremely and 1 indicating dislike extremely. The tasting was carried out in a highly illuminated tasting room. Tasters were provided with water to rinse their mouth after each round of tasting and were prevented from communicating with each other to avoid undue biases. Each taster was served with 10 ml of each "kossam" sample and commercial yoghurt in different coded form.

Physicochemical attributes

pH: The pH was determined using a Kent EIL 7020 model pH meter. The pH of the beers samples was taken in triplicates.

Total titrable acidity: The total titrable acidity (as percentage w/w tartaric acid) were evaluated in triplicate on all samples according to the method describe by Laye *et al.,* (2006). Acidity was determined by titration with 0.1N NaOH solution and expressed as percentage tartaric acid, 1% phenolphthalein in alcohol was used as indicator

Viscosity: Analyses were carried out on the yogurts after 16 h of storage at 4◦C to determine their physical properties express as viscosity. The viscosity were accessed as describe by Sodini *et al.,* (2005). Before each analysis, the yogurt was gently stirred by making five up and down movements of a spoon in the yogurt cup to ensure homogeneity, as reported by Remeuf *et al.* (2003).

A puncture test was carried out with a TAXT2 texture analyzer (Stable Micro Systems Ltd, Haslemere, UK) using a 2.5-cm acrylic cylinder probe. The test speed was fixed at 2 mm s^{-1} and the penetration depth was 10 mm. The sample temperature was 4◦C. The test was replicated three times. Firmness was defined as the force necessary to reach the maximum depth.

Statistical Analysis: Data was subjected to analysis of variance and means were separated using Duncan's multiple range test at $P<0.05$ (Steel and Torrie, 1980).

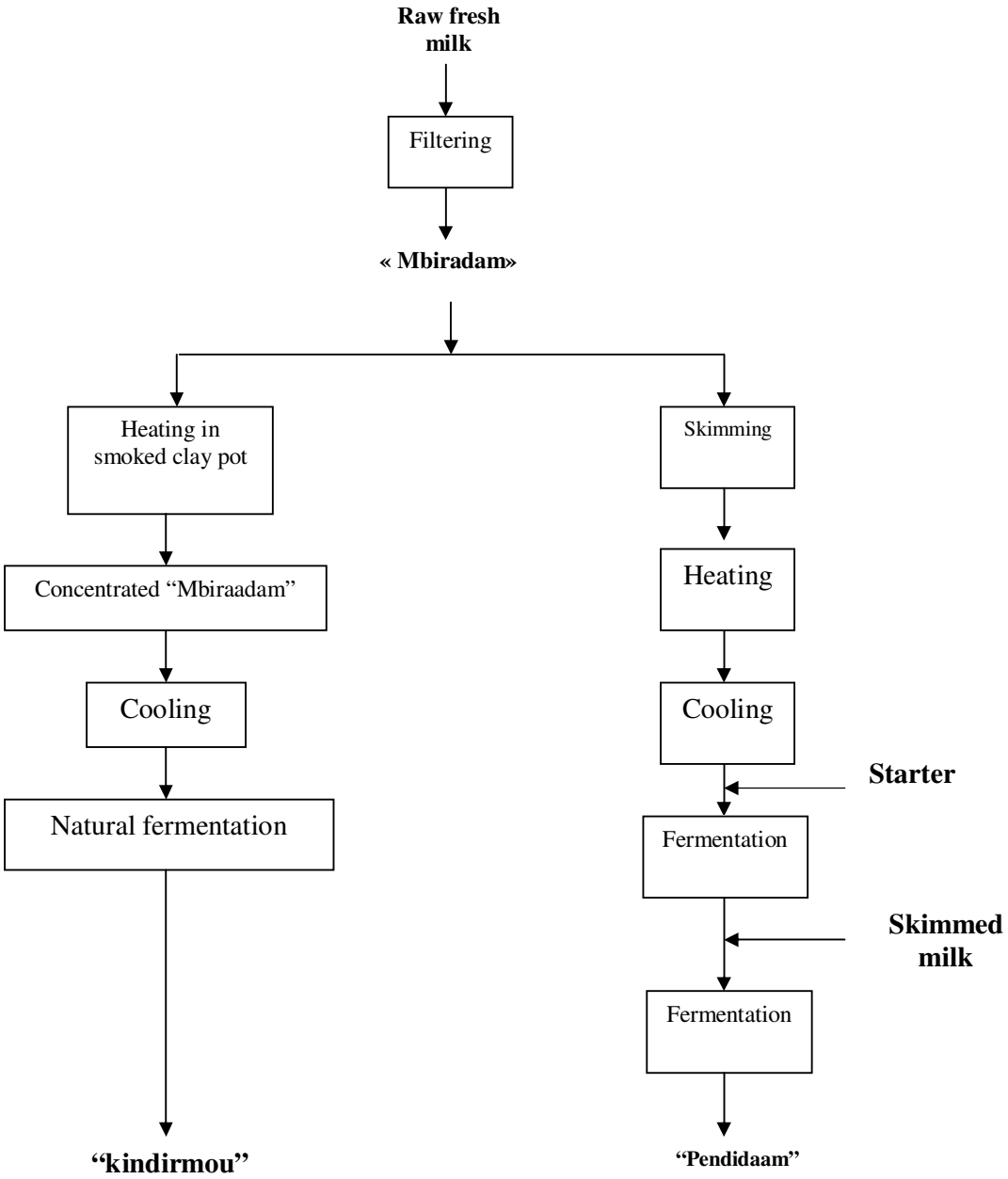

Fig 1: Artisanal process production of "kossam" (mbiraadam, kindirmou, pendidaam)

3. RESULTS AND DISCUSSION

Artisanal production of "Kossam" in rural area
All identified fermented milk product in the area are designated by the generic term Kossam which means "milk" in Fulani (Kuhn, 2004). Depending on the type of processing and nature of the final products, the specific terms were found to be as follows:

-"mbiradam" which stand for raw, fresh, unfermented and not skimmed milk (whole milk),
-"kindirmou" in the local language Fulani, means "heavy milk" indicating heated, concentrated and fermented whole milk (mbiradam),
-"pendidam" which means in hausa fermented milk, acid derived from "mbiraadam" skimmed

heated and fermented. It uses no additives although some prefer to add urchins.
The general processing method for "kossam" (fig 1) includes filtering the raw milk into a smoked clay pot or bottle gourd, the obtained beverage called "mbiraadam" is equal to fresh pasteurized commercial whole milk. "mbiraadam" can be stored for 5 to 10 hours at ambient temperature or 24 hours at refrigerated temperatures (4˚C).
"Mbiraadam" can also be transfered in a vessel to a warm place (35˚C - 40˚C) for 12 h to 24 hours until the milk got soured and coagulated. This new product is called "kindirmou" and can be use as commercial yoghurt or for infants feeding.
"Mbiraadam" can be skimmed then heated and cooled. An old fermented "kindirmou" is then use as a starter culture to heated skimmed "mbiraadam" after 12h to 24hours a sour milky thick beverage is obtained and called "pendidaam'. This late can be store for 24 hours at ambient temperature or 2 weeks in a refrigerator. Fresh batches of milk may be added each day with or without previous removal of whey, until the gourd or clay pot is full. The fermented milk may be consumed as such (straight fermented milk) or as in the majority of cases; it is churned to produce butter. The buttermilk is then consumed at the household level or sold or exchanged for grains (Kerven, 1987).

Artisanal production of "Kossam" in urban area.

In towns or urban metropolis, the use of artisanal processing of "kossam" is limited due to the short shelf life of fresh milk usually available in rural areas, and lack of availability of handling and packaging material. At domestic levels, "kossam' is prepared mostly from reconstituted milk powder. Interrogated women indicated that if traditionally "kossam", it is made from freshly extracted cow's milk. This late one is not always available in town. To tackle this, people innovated by the use of milk powder sugar and commercial yoghourt as starter culture to produce a "kossam" which is similar to "pendidaam". This product manufactured locally to a wider audience in urban areas called "kossam" is kept in diverse package for sale as "yoghurt" drinks in schools, offices, minimarkets and event in the street (Essomba *et al.*, 2002). The packaging materials uses here are mainly old soda or mineral water 1.5L polyethylene bottles. The process itself is different at many points from artisanal process (fig.2). The main ingredients which is milk is coming from reconstituted commercialized and imported milk powder, white granulated sugar is also always added while in artisanal process the addition of sugar is mainly optional and occur mainly at the consumption time ie when the final product is already produce. The following process (fig. 2) resumes how "kossam" is manufacture in urban area and at domestic levels. The main ingredients are: milk powder, water, commercial yoghurt, table sugar.
Preparation of curd: peoples mainly make use of a plastic bowl for this recipe and never use an aluminum bowl. First the powder is poured into the bowl and small quantity water. Then the mixture is mix until it becomes smooth and uniform. Then hot water is added again and mix. The total amount of milk powder/ water ratio at the end of the process is approximately 120g to 160 g of milk powder for 1 L of clean water. When the reconstituted liquid milk is sufficiently mixed, granulated sugar is added at the rate of approximately 65g/l of reconstituted milk. Then this late mixture is bringing to boil until granulated sugar got diluted. Finally after a short period of cooling until the mixture of milk powder, water and granulated sugar reached 30˚C to 40˚C, and organic commercialized yogurt pot or an old fermented "kossam" is added at approx ratio of 10%V/V. The container is then closed with a lid and stored in a warm environment, cover with 2 towels and let ferment for 12h to 20 h depending of the rate of needed acidity at the end of the process.

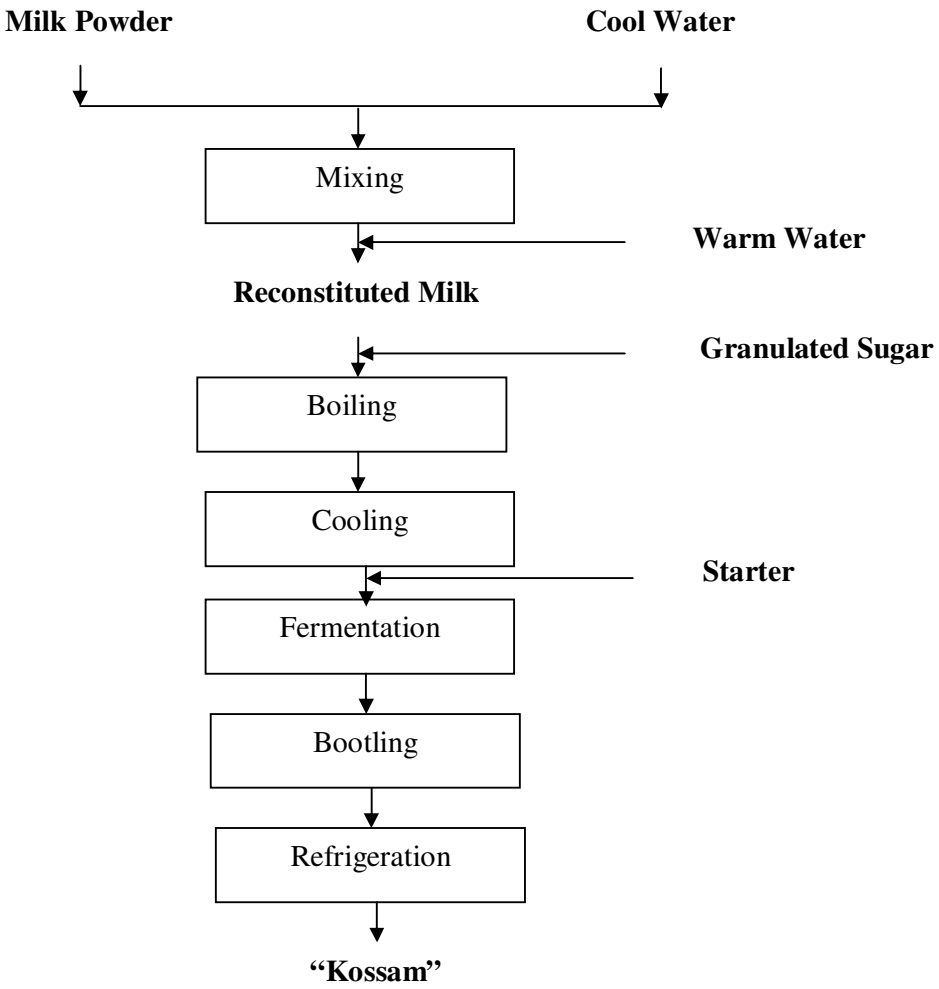

Fig 2 Domestic production of "Kossam" in Cameroon urban areas

Another method is to distribute evenly the late boiled mixture of milk powder, water and sugar, directly in 1liter PET containers then live it lightly cooled and add starter at the same ratio (approx 10%V/V) in each container, before allowing all to be fermented in warm environment. After fermentation, the milk is creamy and tastes a lightly sour. It's then keep in refrigerator at approx 4°C for minimum 12 h and sold as "kossam" in local urban markets and stores, by street vendors in cooler or packed in small plastic then cool until ice before being sold to school children at canteen. It can also be serve with boiled rice or maize meal, it's then locally called "dakere". The "kossam" produce in urban areas can be stored in the refrigerator for at least 2 weeks.

Small local factories are now producing "kossam" following similar process from reconstituted milk powder. They have diversified their offer by conditioning "kossam" in yoghurt pot, small-swiss, ice cream, reconstituted pasteurized milk or sterilized bottle in bricks.

It may be pointed out that although the names "kossam" is similar to both products (urban and rural product), it doesn't indicate the same product. In rural area, "kossam" stand for tree different products (mbiraadam, kindirmou and pendidaam), in urban area, it's only use for "pendidaam" ie reconstituted fermented milk powder which is similar to commercial Yoghurt.

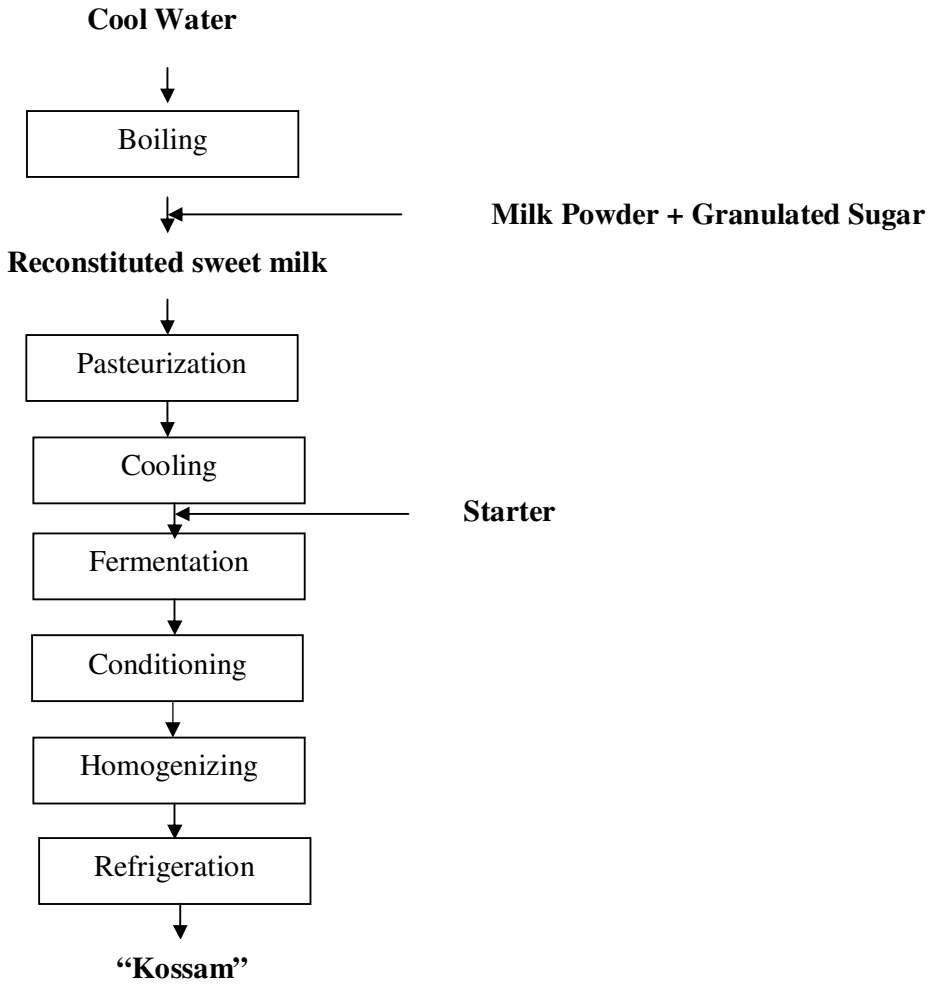

Fig. 3 Laboratory scale production of "Kossam": new flow sheet design for industrial process

Standardization of the production process of "kossam".

In order to promote this artisanal product, the following process production was set up using both artisanal process production and considering HACCP. This industrial process design for "kossam" was set up as describe by **Douglas (1988)** using both rural artisanal process and urban innovation as based model.

If for small scale production fresh liquid milk is mainly use, for industrialization purpose, it will be suitable to consider using milk powder than fresh milk as this late may not be available all the time and also to reduce risk of contamination. In addition the physicochemical parameters of fresh milk may not be standard for each batch. This can influence the constant quality of the end product requires for commercial purpose. With dry powder, almost major physicochemical parameters may be mastered (water content, pH, dry mater…) leading to a standardized and constant product quality over the time on the market.

Boiling water prior to add milk powder and sugar may prevent some biochemical reaction during heating process like caramelisation or maillard reaction (McKenna, 1988; Brands, & Van Boekel, 2001). The pasteurization process after reconstitution of milk and sugar may also reduce risk of microbial proliferation (Angulo *et al.,* 2009).

The starter uses here is proposed to be lightly different from commercial yoghurt starter

composed only of *Lactobaccillus bulgaricus* and *Streptococcus thermophillus* strains. We intend to add two more strains *Lactobaccillus plantarum* and *Lactobacillus fermentum* strains as they were recorded in previous study as dominant microorganisms of the natural fermentation of milk into "kossam" and may have great influence on textural and organoleptic qualities of the final product (Jiouwa and Millere, 1990; Kaktcham, *et al.,* 2012). As the strains seems to have similar influence on organoleptic and physical properties of the end product, the rate of 25% *L.bulgaricus*, 25% *L.plantarum*, 25% *L. fermentum*, and 25% *S.thermophilus* were proposed for industrial production process, and adopted for the laboratory scale production process. The temperature of 35˚C were also adopted as more close to the recorded temperatures from natural artisanal fermentation of pendidaam and other artisanal produce fermented milk (Shalo *et al.,* 1987; Jiouwa and Millere, 1990).

Given this, ratio of 120g/l of dry milk powder and 60g/l of granulated sugar were use to reconstitute liquid milk. First the two dry powders (cow milk and granulated sugar) were weighted then approx half quantity of warm water were added and mix until a mixture similar to concentrated sweet cow milk were obtained. This late was further completed by warm water to desired volume. The obtained diluted sweet cow milk were then pasteurize at 80˚C for 15 minutes. After pasteurization the mixture were allowed to cool down at room temperature until it reach approx 35˚C. The mixture of reconstituted starter culture were then added and mixed thoroughly. It was then allowed to ferment in an incubator with temperature sets at 35˚C for 10 hours. After incubation time a flavor beverage with soft texture were obtained. This late was cooled down then homogenizes and refrigerate at 4˚C for 10 hours. Aliquots were then used for sensory and physicochemical parameters evaluation. The water-holding capacity of the artisanal "kossam" samples was 300±15 g kg^{-1} and 500±55 g kg^{-1} for laboratory made "kossam" samples this may be explained by the constant cycle of homogenization which can causes a change in water holding capacity of milk proteins, which tends to reduce syneresis (Hu *et al.,* 2000). Significant difference (P<0.5) for total titrable acidity determined as Dornic acid (˚D) were recorded between artisanal "kossam" (97±3), laboratory produce samples (90±2), and commercial yoghurt samples (70±5). Recorded pH indicated values of 3.1±0.2 for artisanal kossam; 3.5±0.7 for laboratory made kossam; 4±0.9 for commercial yoghurt. If there were no significant difference (p<0.5) between artisanal kossam and laboratory made kossam, we noticed a significant difference (p<0.5) between commercial yoghurt and all kossam samples (artisanal and laboratory).

Table 1. Comparative studies of physicochemical parameters of different "kossam" samples

Physicochemical parameter		Artisanal kossam	Laboratory made kossam	Commercial yoghurt
Water holding capacity(g kg^{-1})		300±15	500±55	nd
Total titrable acidity (˚Dornic)		97±3	90±2	70±5
pH		3.1±0,2	3,5±0,7	4±0,9
Viscosity	**Lower firmness (g)**	10±2	13±1	18±2
	Lower Brookfield viscosity (Pa s)	4±1	5±1	10±2
	Lower complex viscosity (Pa s)	10±2	11±2	30±5
	Lower apparent viscosity (Pa s)	0.2±0.0	0.3±0.0	1.0±0.0

nd: not determined

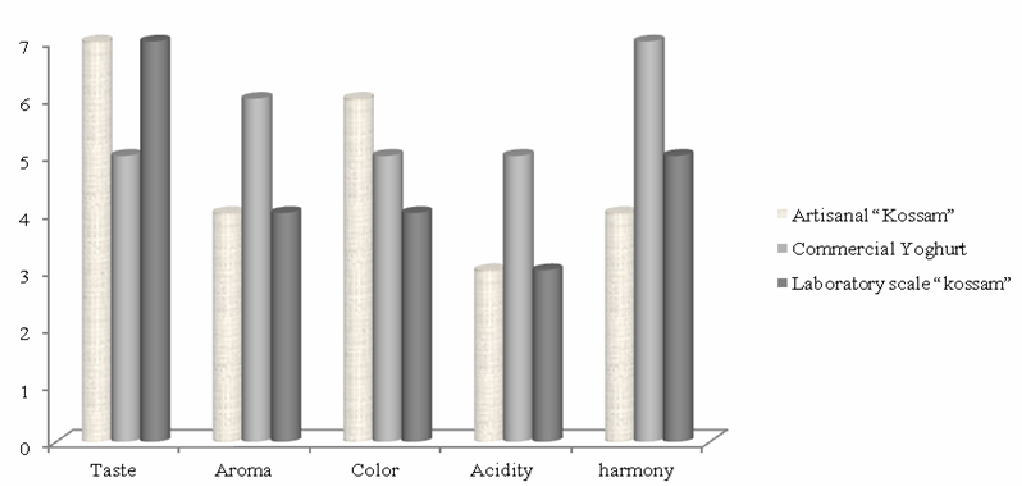

Fig. 4 Sensory attributes of traditionally and Laboratory made "Kossam" compared to commercial yoghurt indicate

It may be pointed out that this correlate well with the fact that the increases in the acidity of milk were notice previously on heating it was also established the fact that the amount of acid produced is proportional to the temperature and duration of heating (Grimbleby, 1954). This acidity may also be correlated with the types of microorganisms originating from the milk (Garvie, & Mabbitt, 1956).Within the tree samples of studied milk product rheological properties, the lower firmness parameter indicate that artisanal kossam is less firm than the two other samples (laboratory made kossam and commercial yoghurt with lower firmless values varying from 10±2 (g) for artisanal produce kossam compared with 13±1 g and 18±2g for laboratory made kossam. Lower brookfield viscosity indicate significant difference ($p<5$) between all kossam samples (4±1 Pa s for artisanal kossam and 5 Pa s for commercial kossam) and commercial yoghurt. The two other rheological properties (lower complex viscosity and lower apparent viscosity) present similar path with significant difference ($p<0.5$) between commercial yoghurt sample and artisanal kossam as well as laboratory made kossam.

Sensory attributes of "kossam".

The sensory evaluation of different "kossam" samples compared to a commercial yoghurt (fig.4) indicate that there is no significant difference ($P<0.05$) between artisanal kossam and commercial yoghurt compared to laboratory made "kossam". It has also to be noticed that artisanal kossam and laboratory made kossam seems alike compare to commercial yoghurt if aroma, taste and acidity are concern. This may be due to the fact that these sensorial attributes (taste, aroma and acidity) are likely to be influence by the nature of microbial phenomena occurring during fermentation process (Wouters *et al.,* 2002) since the microbial composition of natural "kossam" flora were alike it is understandable that those attributes being similar. The total harmony indicates that commercial yoghurt presented a better overall acceptability than artisanal and laboratory made "Kossam" this can be explained by the fact that commercial yoghurt presented constant scores in many tested parameters (fig. 4) (Irigoyen *et al.,* 2005)

4. CONCLUSIONS

For years, the dairy development schemes promoted in Africa has promoted the establishment of industrial milk plants. But this cannot be successful without valorization of locally produced and transformed milk. The kossam can be one of the key issues of local transformation if the process production scheme is well mastered. This work aiming at

carrying out investigations to describe the artisanal process production of "Kossam" permits to identify critical points and standardize production process. A new flow sheet production process is proposed and is intend to be used at industrial level to standardize all "Kossam" production.

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