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Trial of soya milk yoghurt production and its organoleptic study in Lubumbashi, D.R. Congo

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Summary: The study focused on the preparation of yoghurt from soya milk in the city of Lubumbashi. The objective of this study is to extend the shelf life of soybeans while diversifying and preserving them in various forms, particularly soy yogurt. This product of vegetable origin is cultivated everywhere in the city of Lubumbashi but the population suffers from infantile malnutrition because it is consumed in only one form; the soya flour and the population does not have access to the various products derived from the soya.

In order to produce yoghurt, the soya milk was produced by taking 1 kg of soya beans and soaking them in 1 litre of lukewarm water for 24 hours, then grinding them until a paste was obtained, to which 5 litres of lukewarm water were added. The resulting solution was homogenized, filtered, heated to 85°C for 30 minutes (pasteurization) and then left to stand for 10 minutes. The operation was repeated for a second time to accelerate coagulation. The second pasteurization of the milk allows the destruction of pathogenic bacteria. The milk was then cooled to a temperature between 42 and 48°C. Since this milk is a vegetable product, the addition of lactose is necessary to produce lactic acid. Thus, 500 ml of soy milk were taken and 500 ml of FINTA milk (cow's milk) were added. This mixture was heated to 48°C. 125ml of ferments (*Streptococcus thermophilus* and *Lactobacillus bulgaricus*) were added. The mixture was stirred and covered to ferment for 6 hours. Then 50gr of sugar was added to the mixture. Then the product was packed in plastic bottles and put directly in the refrigerator at a temperature of 2 to 4°C. Thus the yoghurt was born.

In this product of vegetable origin, two organoleptic analyses were carried out with taste, colour, consistency and the personal appreciation of the taster as parameters. In the second analysis an improvement was observed on the colour, the consistency and the appreciation but for the taste, we find that it is necessary to play on the aftertaste of the legumes by adding the ingredients to hope for an improvement.

Keyword: Streptococcus thermophilus and Lactobacillus bulgaricus, FINTA milk

Introduction

The Democratic Republic of Congo is among the underdeveloped countries in terms of processing agricultural products into finished products, where the entire population does not have regular access to imported (processed) products due to high prices (Martin et *al*; 2011).

Furthermore, the population of Lubumbashi is confronted with serious health problems often linked to food insecurity. These problems are due to the difficulties of access to a balanced diet, in sufficient quantity and throughout the year (FAO 2005).

The palliative solution to this problem would be to resort to less costly protein sources of plant origin such as soybean. Indeed, the city of Lubumbashi has favourable climatic and ecological conditions for the cultivation of this legume. Soya is an annual plant, rich in protein (40% of dry matter) and containing about 20% of oil and is cultivated on a large scale in the city of Lubumbashi. For its preservation, the population mainly uses the drying method and soya is traditionally consumed in the form of flour only. However, soybeans are consumed elsewhere in the form of soyfoods, a term that includes various preparations from whole beans (fermented products, soy juice or tonyu, tofu, etc.) (Amrane A. 2012). This shows that many crop losses are recorded for this crop. Hence the interest to resort to other ways of transformation to diversify the presentation of soybean products. Yogurt is a preparation of animal or vegetable milk whose fermentation is carried out by two

bacteria; *Streptococcus thermophilus* and *Lactobacillus bulgaricus.*

Environment Materials and Methods

This experiment was conducted during the 2018-2019 cropping season at the Research Station of the Faculty of Agronomic Sciences of the University of Lubumbashi (UNILU). The site is located at 1243 m altitude, 11°39' South latitude and 27°28' East longitude. The climate of Lubumbashi is characterized by the alternation of a rainy season (November to May) and a dry season (May to September), with October and April as the transition months. July and August are the driest months. The average annual rainfall is 1270 mm with a rainy season of 118 days, while the average annual temperature is about 20°C with a great interannual stability. The average humidity is 62% with a minimum average humidity level of 52% in the dry season (June - August) and a maximum of 80% in the rainy season (November - May).

The soils of Lubumbashi and its surroundings are dominated by yellow, ochre-yellow and red ferralitic soils depending on the topographic position and drainage. The vegetation of Lubumbashi is made up of three main types of vegetation formations which are: the savannah, the steppe and the forest. The forest represents more than 80% and is presented under three aspects: the clear forest, the edaphic forest and the dry forest.

The study focused on soybeans (genus *Glycine*) grown in Katanga and were purchased at the NJANJA market. A thermometer, two plastic basins, a sieve, a brazier, a saucepan, a pestle and mortar were used to prepare the soya milk to yoghurt.

1 Kg of soybeans was soaked in 1 litre of warm water for 24 hours, then crushed until a paste was obtained to which 5 litres of warm water were added. The solution obtained was homogenized and then filtered, subjected to fire at a temperature of up to 85°C for 30 minutes (pasteurization), then left to stand for 10 minutes. The previous operation was repeated for a second time to accelerate the coagulation of the solution.

The second pasteurization of the milk allowed to destroy the pathogenic bacteria. The milk was then cooled to a temperature of between 42 and 48°C. Since this milk is a product of vegetable origin, the addition of lactose is necessary to produce lactic acid. Thus, 500 ml of soy milk was taken and 500 ml of imported FINTA milk (cow's milk) was added. This mixture was heated to 38°C, 125ml of the ferments were added. The mixture was stirred and covered to ferment for 6 hours. Then 50 g of the sugar was added to the mixture. After this operation, the product was packed in plastic bottles and then directly chilled to a temperature of 2-4°C.

The added ferments consisted of two micro-organisms (lactic acid bacteria) that promote fermentation.

These two live incorporated bacteria are:

- ***Lactobacillus bulgaricus***, which gives the yogurt its acidity and
- ***Streptococcus thermophilus*** develops the aromas

Sugar (glucose) is added before packaging because at this time the bacteria are no longer active.

Three phenomena are observed during the 6 hours of fermentation:

- The bacteria reproduce by the millions and then transform part of the sugar (lactose) added to the milk into lactic acid " it is the lactic fermentation ";
- The production of lactic acid acidifies the milk and thus leads to its coagulation and the development of aromas;
- The milk gelled, the yogurt was born.

Figure 1 shows the manufacturing process of soy yogurt.

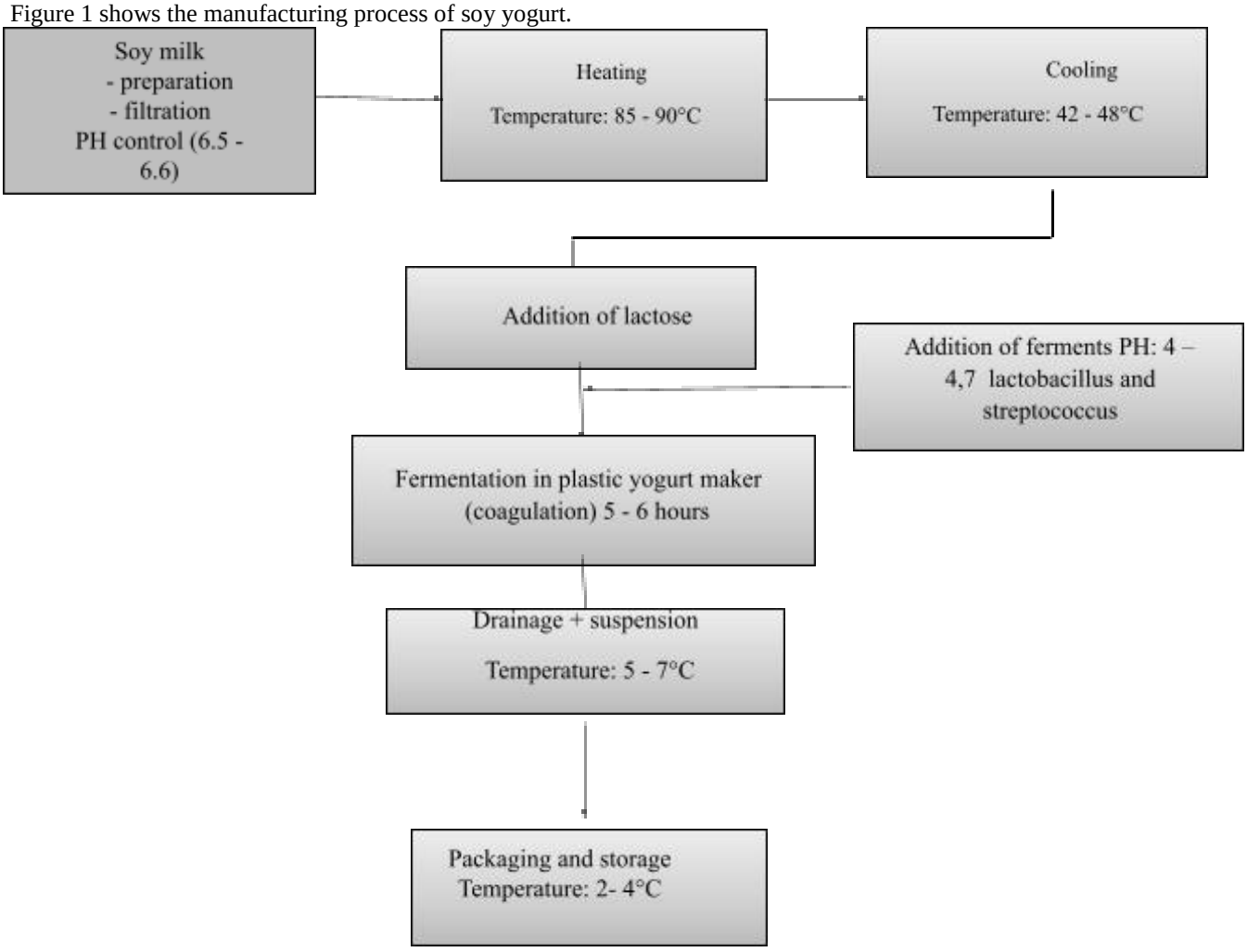


Figure 1: Diagram of the preparation of soya yoghurt

Results

The analysis was based on the determination of color, taste and consistency on the three samples, namely: the yogurt of the **brioche** (first supplier on the local market), the one prepared locally at the faculty (experimentation) and the one of **megastore** (second supplier on the local market), with 10 tasters to appreciate. For the local sample, a second preparation was necessary to solve the deficits of the previous preparation. This also allowed a second organoleptic analysis.

The parameters observed concerned:

- **Colour**: traditionally, fresh milk has a dull white colour, which becomes more yellow when it is richer in cream. The yellowish-white colour of soya milk is very noticeable if the filtration is not complete.
- **Taste**: as a plant species, soya has a characteristic taste of its kingdom, but this can disappear with the improvement of milk production.
- **Consistency**: this is achieved when the milk is mixed with ferments at a controlled temperature.

The results on the organoleptic parameters were processed with the statistical software R which allowed us to have the histograms and to see if there is a significant difference or not between the parameters of the same sample.

Table 1 presents the results of physico-chemical analyses carried out on milk and soy yogurt. These analyses were carried out on the following parameters: fat content, dry matter content, protein dosage, carbohydrate dosage, pH measurement, density measurement as well as the dosage of vitamin C and vitamin E. In order to have an idea on the rates of our parameters and compared them to those recommendedby the WHO.

Table 1: Physico-chemical analyses

Constituents		**Soy milk**	**Yoghurt**
Mr. fatty		13,8 %	11,11 %
Dryer		40 %	40 %
Ash		0,5 %	1 %
Protein		15,23 %	2,24 %
Carbohydrate		4 %	5 %
PH		3,60	2,91
Density		1,1335 %	1,0032 %
Vitamin	**E**	Absent	Absent
	C	Present	Present

The results of the microbiological analyses highlight a quality control of foodstuffs based on reducibility and the search for indicators of pollution (tables 2 and 3). The reductase test shows that the yoghurt does not change colour on immediate observation and after 15 minutes, but after 1 hour it changes colour, while the soya milk does not always change colour even after 3 hours. Regarding the search for indicators of pollution, the results show that the **Agar nitrient** at incubation at 37°C for 48 hours gives a number of 13056 aerobic mesophilic germs in yogurt and 2836 germs in milk. The determination of total and faecal coliforms by Eosine Blue Agar (EMB) as a culture medium, incubation at 37°C for 48 hours shows the absence of total coliforms in the yoghurt and 40 total coliforms in the milk and the absence of faecal coliforms in both products at 44°C for 72 hours The search for *Clostridium perfringens* germs with *Clostridium perfringens* Agar base as a culture medium, incubation at 37°C for 24 hours shows that the *Clostridium* germ is absent up to 48 hours in both products.

Table 2: Reductase test

SAMPLES	**OBSERVATION**			
	Immediately	After 15 minutes	After 1 hour	After 3 hours
Soy milk	Negative	Negative	Negative	Negative
Yoghurt	Negative	Negative	Positive	Positive

Table 3: Search for Pollution Indicators

DILLUTION / **CULTURE MEDIUM**	**10^{-1}ml distilled water**	
	soy milk	**Yoghurt**
Nutrient Agar incubation : 37°C/48 H	2836 germs	13056 germs
EMB Agar Incubation : 37°C/48 H	40 totals coliform bacteria	Absent
EMB Agar Incubation : 44°C/72 H	Absent : fecal coliform	Absent : fecal coliform
Gelose clostridium (C.P) 37°C/24 H	Absent	Absent

The results of the organoleptic analyses did not show significant differences in terms of taste (p= 0.8731), colour (p= 0.5488) and consistency (p= 0.3867) of the yoghurt for both analyses. The results are shown in Figures 2, 3, 4, 5, 6, and 7 :

First analysis

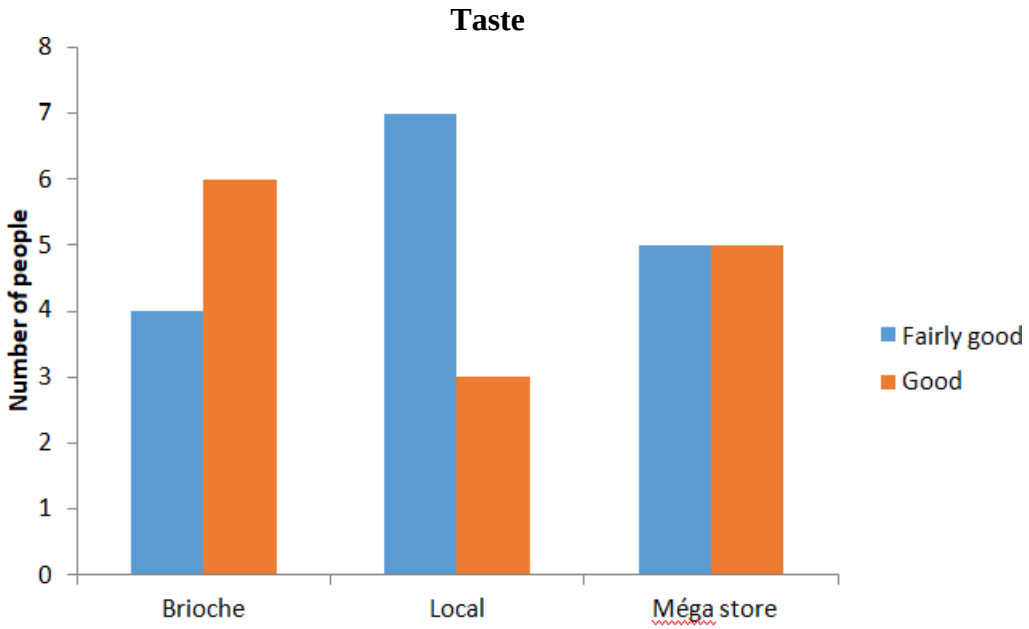
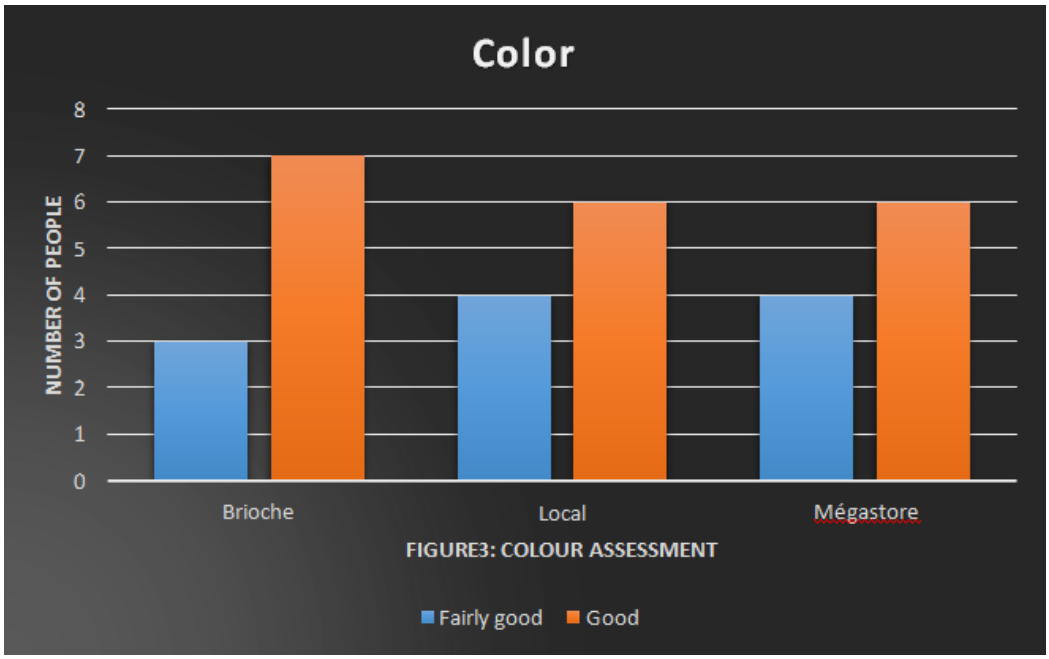


Figure 2: Taste appreciation



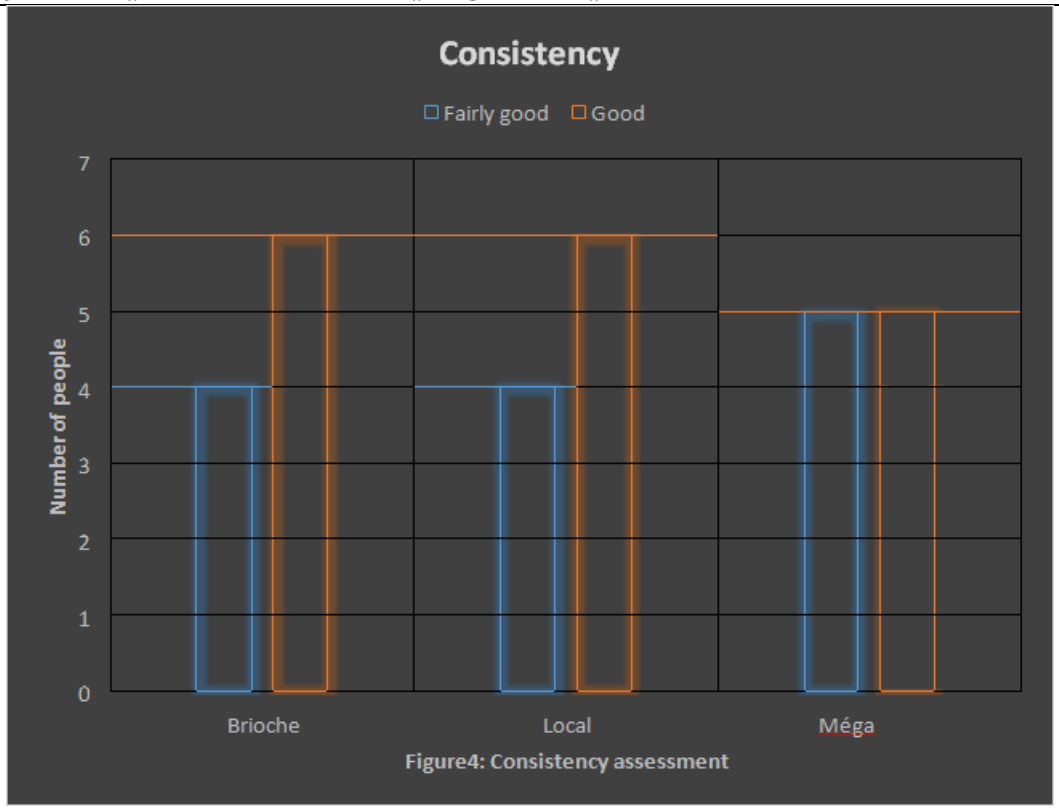


Figure4: Consistency assessment

Second analysis

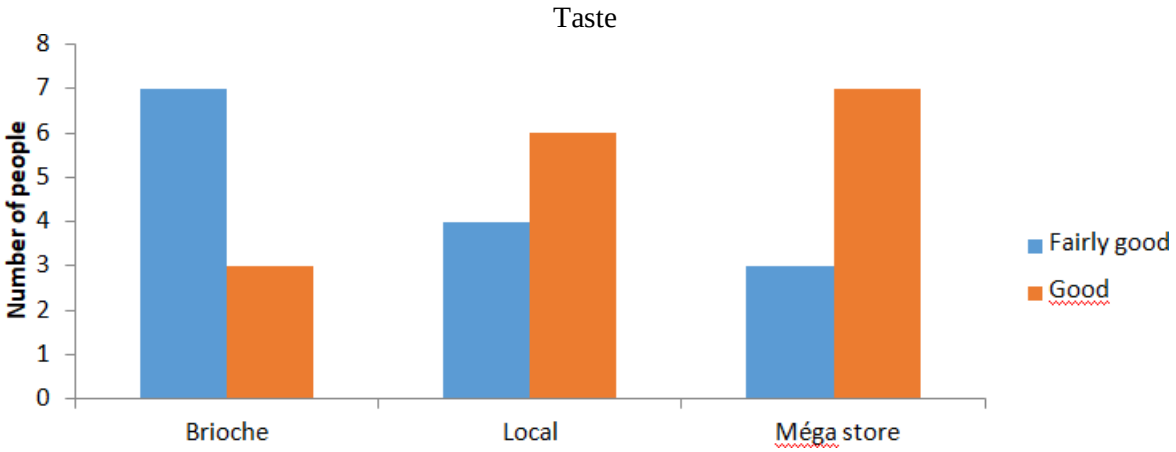


Figure 5: Taste appreciation

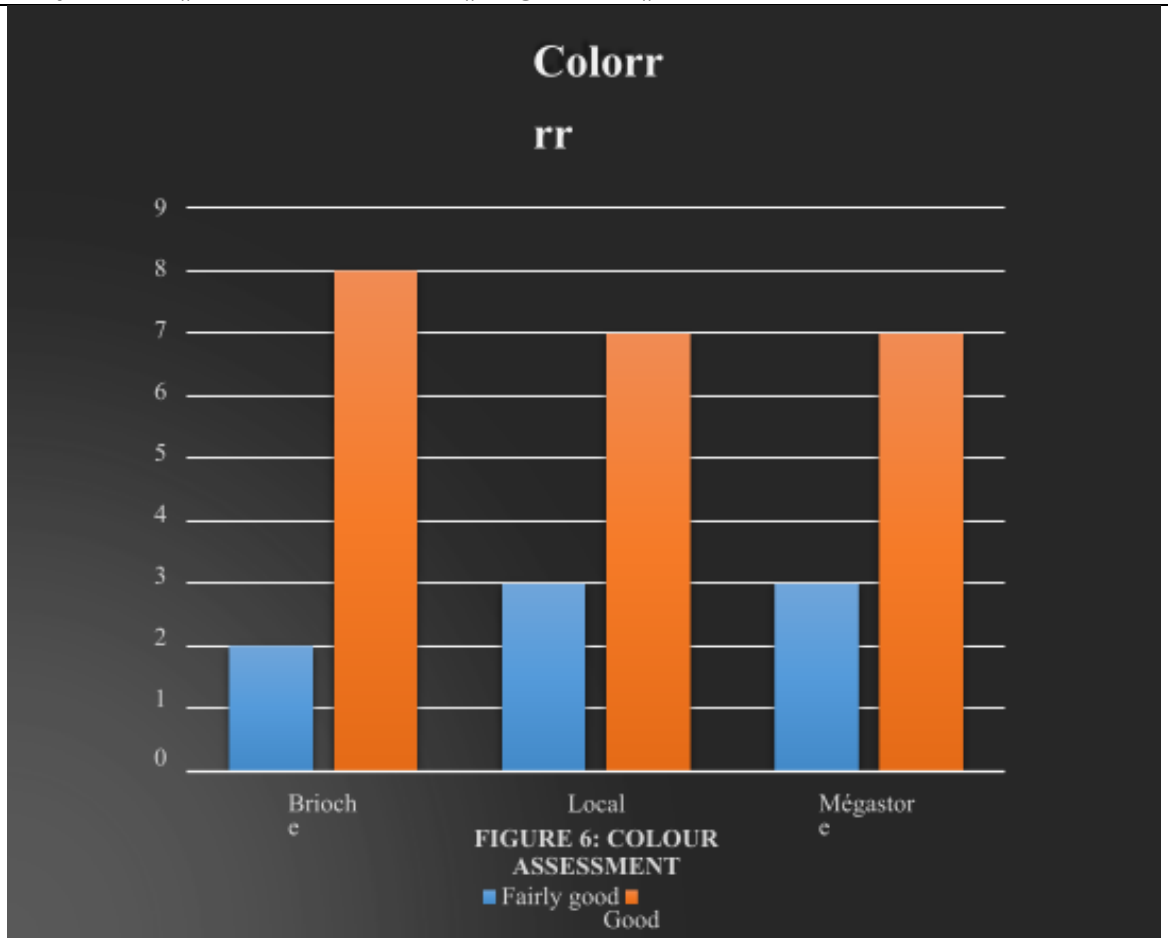


FIGURE 6: COLOUR ASSESSMENT

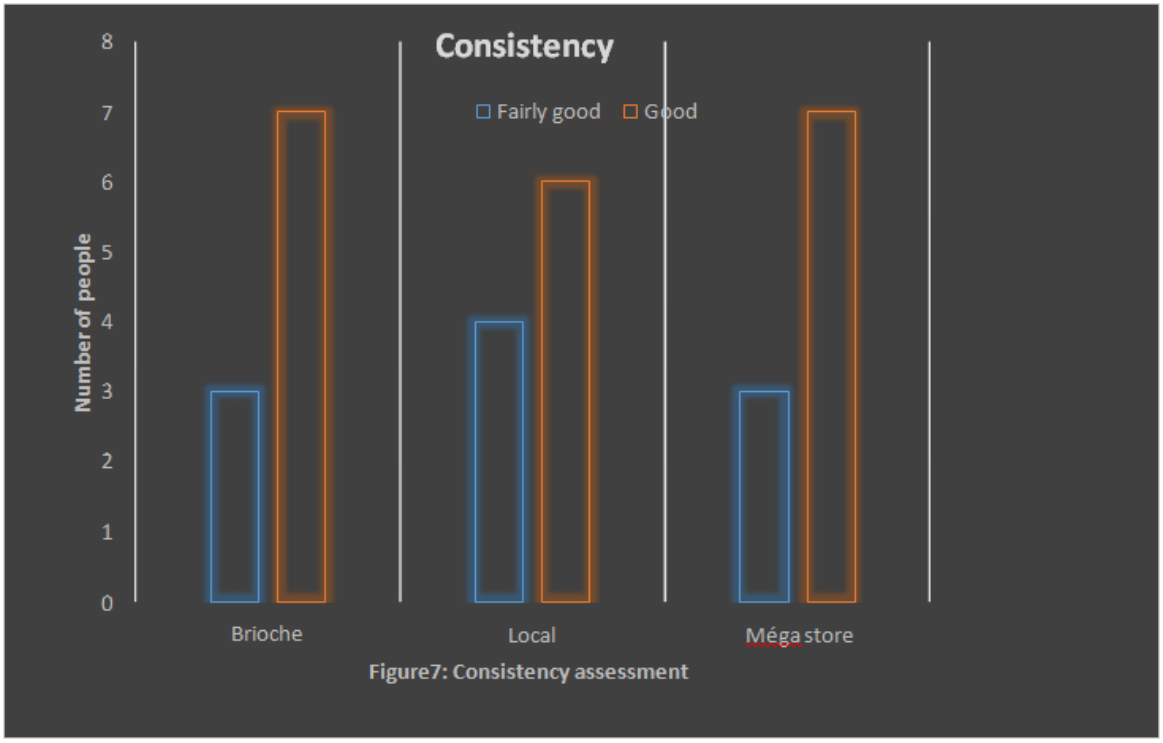


Figure7: Consistency assessment

Discussion

The fat percentage is acceptable (13.8%) for an oleaginous vegetable product such as soya. On the other hand, yoghurt from this product contains less fat (11.11%). This was confirmed by Courtin P., (2002). The dry matter content is the same for both products, i.e. (40%); as for the protein content, each yoghurt producer arrives at a rate according to the process used and the conservation set up before analysis. Indeed, this study showed shortcomings because the protein content was reduced in soy yogurt 2.24% and 15.23% for soy milk. This may be due to poor preservation by the analysts, which would have further promoted a second fermentation thus contributing to the reduction in protein content (Chefrel, 2012). Fermentation acidifies the medium resulting in a decrease in carbohydrates and an increase in the acidity of the sample despite the pH being 3.30 for the soy milk and 2.91 for the yoghurt. Vitamin C was present because the acidification of the medium by lactic bacteria, induces the sour taste of yoghurt and the absence of vitamin E is evidenced by the lack of yellow coloration in the face of nitric acid and this is not a problem because this vitamin would be in negligible quantity in the yoghurt. This was confirmed by Farkye N.Y (2006)

The yoghurt subjected to the reductase test at immediate observation was without turning as well as after 15 minutes but arrived at 1 hour it changed color and this is justified by the presence of ferments in the yoghurt because fermentation turns the coloring when 1ml of methylene blue is added, result confirmed by Davis J.G. (2014). Regarding the search for indicators of pollution, the results revealed that 13056 aerobic mesophilic germs; This value meets the standards set by the WHO to prevent human health. The determination of total coliforms by Eosin Blue Agar (EMB) as a culture medium, incubation at 37°C for 48 hours shows their absence in yoghurt. This is justified by the fact that the preparation was carried out under the strict hygienic conditions that were implemented to protect the yoghurt against contamination that would bring the undesirable germs (Farkye N.Y., et *al* 2006)

The search for *Clostridium perfringens* germs with *Clostridium perfringens* Agar base as culture medium, incubation at 37°C for 24 hours showed that *Clostridium* germs were absent up to 48 hours; negativity was indicated by the absence of a blackish layer on the surface of the solution in the test tube.

The E1 sample was pleasant for more than half of the tasters. On the other hand, sample E2 was poorly appreciated, which is not surprising for the product obtained because it has a strong taste of legumes related to its vegetable (Codex, 2013). From the point of view of coloration, sample E2 was appreciated due to the addition of animal lactose which further increases the white coloration of the yogurt (Hubert p. , 2006). In terms of consistency, samples 1 and 2 were highly appreciated. This is justified by the fact that the seeding was carried out under different conditions with different quantities of ferments. The low values observed prompted us to do a second analysis to improve the quality. Thus, in the second round, an improvement was observed for the yogurt produced due to the second pasteurization of the milk (Berkman T., et *al*, 2012). Despite the numerical difference, the three samples behaved in the same way in relation to taste, color and consistency. Note however, that an improvement on color was observed as the tasters' figure increased from 60% to 70%. Regarding the consistency, all the samples had almost the same percentages, which shows that the conditions of seeding and the quantities of ferments did not change (Bautista E.S., et *al.*, 2011).

Conclusion

The objective of this study was to manufacture yoghurt from soya milk under specific hygienic conditions. To achieve this operation, the artisanal method was used; two lactic ferments (*Streptococcus thermophilus* and *Lactobacillus bulgaricus*), were seeded in soy milk for 6 hours at a temperature varying between 42 and 48 °C in the hygienic conditions recommended by the WHO as evidenced by microbiological analyses that approach the yoghurt of the **brioche** and the **megastore** produced in the conditions and in an industrial way.

This product was appreciated in the same way as the yoghurts produced by the well-known houses. Nevertheless, an improvement should be made on the smell and fragrance. In future studies, we suggest improving the quality of the soy yogurt based on the addition of ingredients to eliminate the aftertaste of the vegetable milk.

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