Effects of Incubation Temperature on the Physical and Chemical Properties of Yoghurt

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***Abstract*—Deterioration of milk-based products such as yoghurt is associated with changes in the environmental parameters during storage. The chemical and physical properties or characteristics of the yoghurt are affected by the production technological parameters like incubation temperature. This research investigated the effect of various incubation temperature on the quality of yoghurt. The milk sample was prepared and a starter culture was inoculated at 40oC temperature into the samples. Incubations were performed also at various temperatures. The pH of fermented sample, viscousity and titrable acidity (TTA) were also determined. Results showed decrease in the pH value as the TTA (acid molecules) and viscousity increased with increasing incubation temperature. An optimum production temperature of 35^{o}C is recommended for the production of yoghurt.**

Keywords—Incubation temperature; Yoghurt; Viscousity; Titrable acidity; Milk

I. INTRODUCTION

A number of reports have emphasized the significance of food fermentation mainly because of the degradation or inactivation of anti-nutritive factors, toxins, as well as an improvement of the digestibility of foods that leads their major role in the diet of different regions [4]. Fermentation in food processing is the conversion of carbohydrates to alcohol and carbon dioxide or organic acids using yeast and/or bacteria, under anaerobic condition [8].

Yogurt is believed to be one of the oldest fermentation products known to humans, originating in the Middle East and Asia [1]. Yogurt is the resultant curd formed, during the fermentation reaction of lactose (milk sugar) in the milk and bacterial enzymes under certain conditions. This fermentation process is anaerobic. Lactose is a compound sugar, made up of the two simple sugars glucose and galactose. During the making of yogurt, the lactose is broken down by the lactase enzyme. In the course of the action of the bacterial enzyme on the lactose, lactic acids and acetaldehyde are produced which in turn lowers the pH of the milk causing it to have a sour taste or tart taste [2]. The pH of milk is about 6.7. However, during fermentation process the pH drops between 3.6-4.5, depending on the operating technological conditions. The lower pH affects the casein (milk protein), causing it to coagulate and precipitate, forming the solid or thick curd that makes up the yogurt. The leftover watery liquid is the whey. The two bacteria most commonly used to make yogurt are Lactobacillusbulgaricus and Streptococcus thermophilus. The starters' milk can be inoculated in various forms using virgin bacteria or as in this project, by already-made yoghurt.

The quality of Yoghurt produced is highly affected by various factors which include the incubation temperature, amount of starter inoculated and the time or period of incubation. These are reflected in the yogurts pH (acidity), titrable acidity, viscosity and Brix of the product gotten. Researches showed that milk composition, applied thermal treatment and the incubation temperature influenced the acidification process and the characteristics of the final yogurt [3, 7, 5, 6]. As the incubation temperature is increased the viscosity of the yoghurt increases, the brix (percentage sugar) reduces, the pH reduces and titerable acidity increases. This results in a thicker gel more firmness and adhesiveness as incubation temperature is increased. Hence incubation temperature plays a major role in determining the quality of yogurt made.

Viscous yogurt is the product of an ideal temperature of yogurt milk and the stimulation of bacteria in starter culture. During the fermentation of milk, the yoghurt formed exhibits certain qualities that ascertain if it is fit for consumption or of good quality. During the process if the incubation temperature is not properly maintained the quality of the yoghurt produced may be of low or poor quality, hence the rate of reaction will be dependent on the incubation temperature. This determines the gel thickness and adhesiveness. This research investigates the optimum temperature at which quality yoghurt can be produced and the effect of the incubation temperature on the quality of the yoghurt.

II. MATERIALS AND METHODS

A small amount of the milk sample was dissolved in distilled water and the pH was determined. 67.90g of the milk samples (cowbell milk) were weighed separately into each empty beaker. Distilled water at 90^{o}C was used to fill the beakers containing the milk samples to its 500ml mark and stirred properly.The samples were cooled to 40^{o}C. Plain yoghurt bought from the supermarket was used as the starter culture.

Inoculation of the milk samples were performed at various temperature.

(b) Incubation Temperature

The incubation temperature for the various samples were at temperature ranging from 30°C, 35°C, 40°C and 45°C

Incubation at 30°c:

The water bath was set at 30°C an hour before the milk samples were prepared. The inoculated milk samples were placed in the water bath for 24hours. The incubated samples were removed from the water bath after 24 hours of fermentation. The samples were stirred thoroughly with a spatula in one direction to make the samples (yoghurt) smooth after which left to cool to about 28°C. Incubations for temperature at 35°C, 40°C and 45°C were performed repeating the same procedure as above.

(c) Determination of the pH of the fermented samples (yoghurt):

The pH meter probe was properly cleaned and checked before use. The pH for the fermented samples and the control sample were conducted using standard procedures. The readings of the pH meter for all the samples were recorded.

(d) Determination of the titrable acidity using back titration:

1M sodium hydroxide was prepared and titrated against 25ml of each yoghurt samples and control sample using 2 drops of phenolphthalein indicator until it was neutralized and turned light pink.The titration was done thrice for each sample.The titre values were recorded.

(e) Determination of the viscosity of the yoghurt samples:

The viscosities were determined using the standard procedure. Each sample was poured into the viscometer cup until it reached the marked point.The samples were properly stirred and the viscosities were checked at different revolutions per minute (30, 60, 100rpm).Viscosity values were recorded at the different rpm.

Control Experiment:

The control experiment was done using Hebron Yoghurt at a temperature of 28°C, the following results were gotten.

(a) The viscousity

Table 1: The viscousity, pH and titrable acidity of the control sample.

pH	3.9
Titrable Acidity (ml)	1.7
Viscousity at 100rpm (cp)	12

(b) pH Analysis:

Table 2: pH of samples at different incubation temperature.

	Sample 1	Sample 2
Incubation Temperature(°C)	pH	pH
30	4.51	4.44
35	4.32	4.29
40	4.20	4.16
45	3.80	3.77

(c) Titrable Acidity (TTA) Analysis of samples:

Table 3: TTA of samples 1 and 2 at different incubation temperatures

	SAMPLE 1	SAMPLE 2
Incubation Temperature (°C)	TTA (ml)	TTA (ml)
30	1.8	1.73
35	2.27	2.2
40	2.7	2.6
45	3.5	3.33

Table 4: Viscousity of samples (at 100rpm) at different incubation temperatures.

	Sample 1	Sample 2
Incubation Temperature(°C)	Viscousity, μ (cp)	Viscousity, μ (cp)
30	56.5	55
35	60	61.5
40	68	69
45	76	75

III. DISCUSSION OF RESULTS

During experimental analysis two samples were collected at each incubation temperature to ensure consistency and accuracy of results.

(a) Variation of pH with the Incubation Temperature

In general, the two quality parameters used to assess yogurt are the pH and the titrable acid. The pH is a measure of the hydrogen ion concentration, while titrable acid (TTA) is the total number of acid molecules and determines the actual hydrogen ion available. The pH value of the yoghurt samples produced are presented in Table 2. The Table shows a drop in the value of the pH for both samples produced. This results shows a decline in pH values as the incubation temperatures increased, i.e. the pH value of the yoghurt is affected by the incubation temperature. The decrease of pH during the storage can be attributed to the high bacterial metabolic activity with the consumption of lactose and lactic acid production which occurred because the increment in incubation temperature was favourable this was similarly observed.

The use of high incubation temperature resulted in a decrease in gelation time and pH values [5]. This decline in the pH results also shows that the incubation temperature affects the acidity of yoghurt. As the incubation temperature was increased the pH of the samples dropped, and the samples became very acidic. Hence the higher the incubation temperature, the higher the acidity of yoghurt.

During fermentation process, it was observed that the pH of the milk samples dropped from 6.7 to about 4.51 to 3.33. This implies an increase in the acid production and this in turn inhibits the growth of pathogenic organisms which can cause food spoilage, food poisoning and disease.

(b) Effects of the Incubation Temperature on the Titrable Acidity (TTA) of Yoghurt

The titrable acidity which measures the acid molecules present was carried out on the samples and an opposite trends were observed in the level of titratable acidity in the yoghurt during analysis. The titrable acidity shows an increase in the TTA (acid molecules) of the yoghurt as the incubation temperature was increased. This shows that there is a proportional relationship between the incubation temperature of the yoghurt and the titrable acidity. The volume sodium hydroxide required to neutralize the yoghurt samples increases with increasing incubation temperature hence there is an increase in the acidity of the yoghurt.

(c). Effects of the Incubation Temperature on the Viscousity of Yoghurt

The OFIT Viscometer was used to determine the apparent viscousities of the yoghurt samples at 28^{o}C in centipoise (cp). The results of the variation of viscousity and incubation temperature are presented in Table 4.5. The viscousity of the yoghurt increases as the incubation temperature is increased. It was observed that as the incubation temperature was increased the gel structure of the yoghurt was firmer and thicker. This in turn caused the yoghurt to be more viscous.

The viscosity is highly affected by the particular temperature of incubation, as some bacteria do not grow well in certain temperatures. It was observed that for two samples incubated at 30^{o}C had certain properties different from other samples which were very viscous and not slimy.

(d) Change in Sensory Attribute

As samples were incubated at different temperatures there was a change and difference in their sensory attributes which includes taste, feel and smoothness. The samples incubated at 30^{o}C were observed to have a creamy and non-tangy taste. The texture was very smooth but not as viscous as those at the others produced at lower temperatures. In the other samples produced as the incubation temperature increased the taste became increasingly sour and tangy, samples also became very thick but less smooth.

IV. CONCLUSION

Yogurt production is affected by the production technological conditions. Increase in the incubation temperature (42-45^{o}C) resulted to increase in the coagulation of the milk protein present (induced by themophilic bacteria) and viscousity. This also resulted in increased acidity of the yoghurt. Yoghurt should not be produced below 35^{o}C as to ensure health safety. Hence the incubation temperature determines both the physical and chemical properties (pH and TTA) of yoghurt as it facilitates the bacteria in the starter to produce viscous yoghurt.

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