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RESEARCH ARTICLE

EFFECTS OF PROCESSING CONDITIONS ON THE QUALITY OF KINDIRMO MADE FROM WHOLE COW MILK AND COW–SOYMILK MIXTURES - II

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ABSTRACT

Three production batches (eight treatments in each batch) of *kindirmo* were carried out in this research to study the effects of fermentation times (5h, 12h and 24h), milk type (whole cow milk and cow–soymilk mixture), starter culture type (kindirmo and DVI – Direct Vat Inoculum) and volume of inoculum (2% and 3%) on pH, titrable acidity and organoleptic acceptability of kindirmo from whole cow milk and cow–soymilk mixtures. The research design was a 2*2*2*3 with milk type being the main factor while the sub-factors were respectively starter culture type, inoculum volume and fermentation time. Titrable acidity, pH and seven-point sensory evaluation Hedonic test for taste, colour, sweetness, texture, mouth-feel and general acceptability were the analyses carried out on the 24 kindirmo treatments. Ranking test was also conducted on the different kindirmo treatments in each production batch. SPSS (Statistical Package for Social Sciences) was used to analyze the means, analyses of variance (ANOVA) and Duncan Multiple Range Tests (DMRT). Results showed pH to be 3.60 – 6.40 while titrable acidity was 0.030 – 0.237 each indicating levels of fermentation. Sensory score ranges were 2.7 of SD2%-5h to 64 of CD3%-24h for flavour, 4.0 – 6.8 of SD2%-24h for colour, 2.9 of SD2%-5h and SK3%-12h to 6.1 of CD3%-5h of taste and for sweetness we have 2.9 of SK3%–12h to 6.1 of CD3%-5h. Texture ranged from 3.0 of SK2%–12h to 6.3 of SD2%-24h and SD3%-24h, mouth-feel from 2.6 of SD2%–5h to 6.3 of SD2%-24h and SD3%-24h, general acceptability from 2.5 of SK3%–5h to 6.4 of CD2%-24h while ranking range from 3.1 of SK2%-24h, SK3%-24h and CK2%-24h to 7.2 CK3%-5h. ANOVA on the entire 24 kindirmo treatments i.e. for all the three batches showed that percentage inoculum volume, starter culture and milk types and fermentation times have significant effects on the titrable acidity, pH and all the sensory attributes of kindirmo ($P \leq 0.05$). However, separate ANOVA for each production batch exclusively for each of these factors, showed that significant differences ($P \leq 0.05$) occurred among the kindirmo for all the productions (batches). Finally as in the first research of "effects of processing conditions on the quality of kindirmo made from whole cow milk and cow–soymilk mixtures – I", it was also observed in this second research of "effects of processing conditions on the quality of kindirmo made from whole cow milk and cow–soymilk mixtures – II" that the most acceptable *kindirmo* treatments were from all treatment factors. They were inoculum volume ratios (2% and 3%), starter culture type (DVI & *Kindirmo*) and milk type (whole cow milk & cow-soymilk composite) and fermentation times (5h, 12h and 24h). Finally we also conclude that the 2% and 3% inoculum to milk volume ratios used were all acceptable. Also 20% cow milk substitution with soymilk was equally acceptable to the *kindirmo* consumers.

INTRODUCTION

Several fermented milks exist in different parts of the world. The fundamentals of peculiarities of these various fermented products are greatly influenced by the cultures and traditions of their place of origin. Fermented milk is central in the dairy industry because it is the point from which other products are made (Thapa, 2000). *Kindirmo*, though not the same with yoghurt, is a traditional full-fat fermented cow milk product (Igwe and yakubu, 2000). It is popular in Northern Nigeria and usually produced at the household level especially by women of the *Fulani* tribe herdsmen (Eneji and Mshelbwi, 1985). Kindirmo processing is affected by type of milk substrate (Igwe, 2011; El Zubeir Ibtisam and Marowa, 2009). Also starter culture type and volume as well as fermentation temperature and time affect the quality of kindirmo (Ezeaba, 2001; Ukeyima, 2001; Kwaghgeman, 2001; Bamsida, 2002; El Zubeir Ibtisam and Marowa, 2009) Additionally,

pasteurization temperature and time and inoculation temperature are the other processing conditions that affect *kindirmo* quality (Kwaghgeman, 2001).

The gaps and findings in the first paper (Effects of Processing Conditions on the quality of kindirmo made from whole cow milk and cow–soymilk mixtures – I) brought about the need for this paper. The first reason being that it is economically unwise to deliberately age (grow) the starter culture for upwards of 48hrs as against 24hrs of age. This is due to the fact that there is no significant difference between *kindirmo* fermented with starter culture of different ages (24h and 48h) for most of the kindirmo samples ($P \leq 0.05$). Another reason for this research is that the previous experiment was conducted in six batches and hence the need to reduce the batches to three so as to minimize human errors especially in the sensory evaluations and variations in the daily weather conditions such as temperature, humidity, etc. Finally, this led to the setting up of second experiment, which not only eliminates 48hrs age of starter culture, but combines in a single experiment 2% & 3% inoculum volume ratios.

MATERIALS AND METHODS

Materials

Cow milk used for this study was obtained from the animal farm of the Federal University of Technology, Yola (FUTY). Kindirmo used was bought from *kindirmo* sellers within FUTY. All reagents and the commercial starter culture, DVI (Direct VAT Inoculum) used in this study were of Analytical grade and obtained from commercial suppliers. Soybean, vanilla flavour and sugar were purchased from Jimeta main market, Adamawa State.

Research Design

Effects of milk and starter culture types, starter culture volume to milk volume ratio and fermentation time on *kindirmo* quality were investigated on a 2 * 2 *2 * 3 factorial experiment giving a total of 24 kindirmo treatments as shown in figure 1.

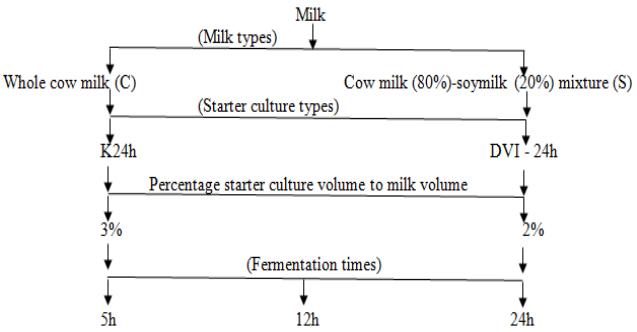


Fig. 1: 2 * 2 * 2 * 3 flowchart for production of 24 kindirmo of different milk substrate, starter culture volume to milk substrate volume ratio and fermentation times

There were a total of three batches of productions of eight *kindirmo* treatments in each batch. The symbols of each of the eight *kindirmo* treatments are given in table 1. Titrable acidity and pH analyses and sensory evaluations were conducted for all the kindirmo samples.

Table 1: Symbols for kindirmo of different processing treatments

N	Symbol	Description
I.	Samples	The same sample codes in each of the three batches of kindirmo productions
1.	CK2%	From whole cow milk (C) using 2% of 24h old kindirmo as starter culture
2.	CK3%	From whole cow milk (C) using 3% of 24h old kindirmo as starter culture
3.	CD2%	From whole cow milk (C) using 2% of 24h old DVI as starter culture
4.	CD3%	From whole cow milk (C) using 3% of 24h old DVI as starter culture
5.	SK2%	From cow-soymilk mixture (S) using 2% of 24h old kindirmo as starter culture
6.	SK3%	From cow-soymilk mixture (S) using 3% of 24h old kindirmo as starter culture
7.	SD2%	From cow-soymilk mixture (S) using 2% of 24h old DVI as starter culture
8.	SD3%	From cow-soymilk mixture (S) using 3% of 24h old DVI as starter culture

Processing operations

Laboratory production of kindirmo from whole cow milk or cow milk-soymilk mixture

The processing flowchart is shown in figure 2. Whole cow milk or cow milk-soymilk mixture was placed in a stainless aluminum pot was heated at 90^{o}C for 15 seconds.

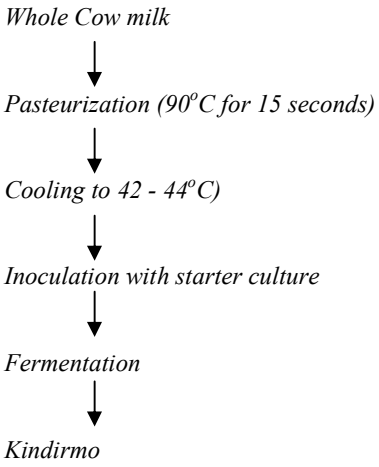
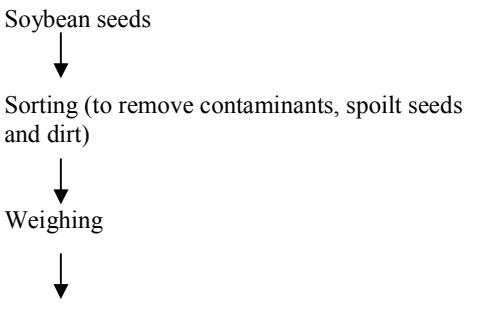


Fig 2. Flow chart for laboratory production of kindirmo

It was then allowed to cool to 42 - 44^{o}C. The heated and cooled whole cow milk or cow milk-soymilk mixture was inoculated with either 2% or 3% of starter culture (either 24h kindirmo or 48h kindirmo or 24h DVI) volume to milk volume. It was then allowed to ferment for either 5h or 12h or 24h to produce *kindirmo*.

Processing of soymilk from soybean

Soymilk production from soybean according to Iwe (2003) is shown in figure 3.



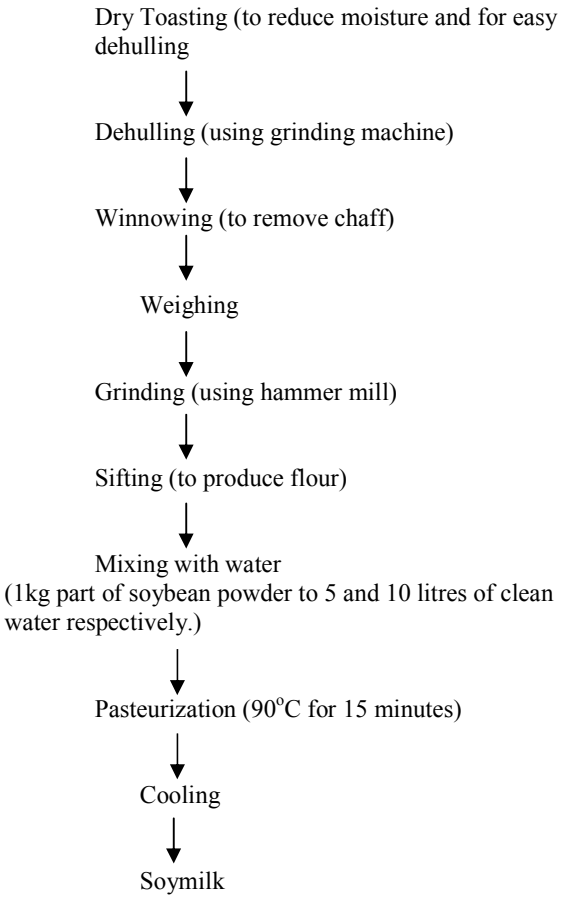


Fig 3. Flowchart laboratory soymilk processing from soybean

Soybean (2kg) was sorted by hand-picking to remove debris. It was toasted in an aluminum pot so as to facilitate subsequent dehulling. During toasting, the soybeans were continuously stirred with spoon until cracks started appearing on the seed coat. It was removed and sprayed on a mat to cool at ambient temperature before dehulling using a dehulling (an adjusted milling) machine. The dehulled seeds were winnowed to remove chaff. The decorticated seeds were then weighed. The soybean seeds were ground to powder using a hammer mill and sifted to a powder using a filter cheese cloth. The soybean powder was then mixed with water in a ratio of 1kg to 10 litres (Based on preliminary test) of water. The mixture was thoroughly stirred before filtering using a muslin cloth. The filtrate is soymilk extract.

Starter culture (DVI, K24 and K48h) preparation.

Fresh cow milk was pasteurized at 90°C for 15 seconds. The pasteurized milk was cooled to between 42 - 44°C and inoculated with 2% starter culture (kindirmo or DVI). It was then allowed to ferment for 24 hours (for K24 and DVI starter cultures) or for 48 hours as in K48 starter culture preparation (Figure 4).

METHODS OF ANALYSES

Protein content was determined by Formol titration while lipid content was determined by the Wener – Schmid method as reported in Pearson's chemical analyses of foods (Kirk and Sawyer, 1991). The AOAC (1990) oven drying method was used for moisture content while muffle furnace method was used for ash content. Carbohydrate content determination was calculated by weight difference. The pH meter and the titration methods were respectively used to determine the pH and titrable acidity (Kirk and Sawyer, 1991)

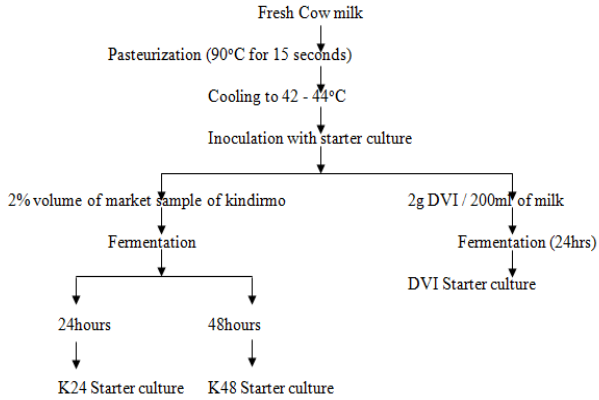


Fig. 4. Flow chart for the production of Starter culture (DVI, K24 & K48)

A seven-point Hedonic test was used on fifteen semi-trained taste-panelists that constituted of year three and five students as well as technologists of Department of Food Science and Technology, Federal University of Technology, Yola. Quality indices evaluated were taste, flavour, sweetness, mouth-feel, texture, overall acceptability and ranking tests. Means, percentages, analyses of variance (ANOVA) and regression were the statistical tools used in the analysis of data. Turkey's test was used for mean separation. Statistical Package for Social Sciences (SPSS) was the computer software used for statistical analysis.

RESULTS AND DISCUSSIONS

The pH, titrable acidity and percentage moisture composition of liquid cow milk, soymilk and soy-powder under different conditions are shown in Table 2.

Table 2: Percentage Moisture, Titrable acidity and pH of Soymilk, Cow milk and Soybean powder under different conditions

S. No.	Milk type	%Moisture	pH	Titrable acidity
1.	Fresh raw Cow milk	$87.68^{c} \pm 0.288$	$6.70^{a} \pm 0.025$	$0.018^{b} \pm 0.001$
2.	Pasteurized Cow milk	$80.92^{a} \pm 0.370$	$6.59^{b} \pm 0.010$	$0.018^{b} \pm 0.001$
3.	Soy Powder	$6.79^{f} \pm 0.183$	$6.38^{d} \pm 0.031$	$0.009^{e} \pm 0.001$
4.	Fresh Soymilk	$94.50^{a} \pm 0.500$	$6.44^{c} \pm 0.010$	$0.007^{d} \pm 0.001$
5.	Pasteurized Soymilk	$93.14^{b} \pm 0.287$	$6.48^{cd} \pm 0.127$	$0.007^{d} \pm 0.001$

Figures are means ± standard deviations of 3no replicate readings.
Within a column, means with same superscript are significantly not different (P = 0.05).

Significant differences ($p \leq 0.05$) in percentage moisture composition, pH and titrable acidity were observed among the different milk samples. The pH of all the samples were between 6.37 – 6.70, which is within the acceptable range (Alfa-laval, 1985). This shows that all the starting materials are weakly acidic and will most likely have uniform effect on the eventual kindirmo produced from them. Table.3 gives the pH, titrable acidity and organoleptic acceptability of twenty-four kindirmo treatments produced in the three batches of three fermentation times i.e. 5h, 12h and 24h. ANOVA on the entire 24 showed that processing conditions have significant effects on the titrable acidity, pH and all the sensory attributes of kindirmo ($P \leq 0.05$). For *kindirmo* fermented for 5h, except for sensory factors of colour and texture, significant

Table 2. Effects of milk and starter culture types, percentage inoculum volume of starter culture to milk volume ratios and fermentation times on the pH, titrable acidity and sensory scores of the 24 kindirmo of different treatments

SN	Trt	pH	T. acidity	Flavor	Color	Taste	Sweetness	Texture	M/Feel	Accept	Rank
I	5h-Ft										
1.	CK2%	$5.47^{c\ (c)}$	$0.050^{ij\ (e)}$	$4.7^{abcd\ (a)}$	$4.5^{bcd\ (ns)}$	$4.0^{abc\ (abc)}$	$5.6^{ab\ (ab)}$	$4.2^{abc\ (ns)}$	$5.1^{abc\ (a)}$	$4.7^{abcd\ (ab)}$	$6.0^{abc\ (ab)} - 5^{th}\ (2^{nd})$
2.	CK3%	$5.47^{c\ (c)}$	$0.050^{ij\ (e)}$	$4.6^{abcd\ (a)}$	$4.3^{cd\ (ns)}$	$5.5^{ab\ (ab)}$	$5.3^{abc\ (ab)}$	$3.8^{abc\ (ns)}$	$5.1^{abc\ (a)}$	$4.9^{abcd\ (ab)}$	$7.2^{a\ (a)} - 1^{st}\ (1^{st})$
3.	CD2%	$6.40^{a\ (a)}$	$0.030^{j\ (f)}$	$3.5^{bcd\ (ab)}$	$4.4^{bcd\ (ns)}$	$4.0^{abc\ (abc)}$	$4.0^{abc\ (abc)}$	$3.2^{bc\ (ns)}$	$3.5^{cd\ (ab)}$	$3.6^{bcd\ (ab)}$	$4.4^{abc\ (ab)} - 13^{th}\ (4^{th})$
4.	CD3%	$6.30^{b\ (b)}$	$0.030^{j\ (f)}$	$4.7^{abcd\ (a)}$	$5.4^{abcd\ (ns)}$	$6.1^{a\ (a)}$	$5.9^{a\ (a)}$	$4.2^{abc\ (ns)}$	$5.4^{abc\ (a)}$	$5.5^{abc\ (a)}$	$4.3^{abc\ (ab)} - 15^{th}\ (5^{th})$
5.	SD2%	$5.10^{d\ (d)}$	$0.062^{hi\ (d)}$	$2.7^{d\ (b)}$	$4.2^{d\ (ns)}$	$2.9^{c\ (c)}$	$3.0^{bc\ (a)}$	$3.2^{bc\ (ns)}$	$2.6^{d\ (b)}$	$3.4^{bcd\ (ab)}$	$3.4^{bc\ (b)} - 21^{st}\ (8^{th})$
6.	SD3%	$4.60^{g\ (g)}$	$0.067^{hi\ (c)}$	$4.7^{abcd\ (a)}$	$4.9^{abcd(ns)}$	$4.3^{abc\ (abc)}$	$4.4^{abc\ (abc)}$	$4.6^{abc\ (ns)}$	$4.8^{abcd\ (ab)}$	$3.3^{cd\ (ab)}$	$3.6^{bc\ (b)} - 20^{th}\ (7^{th})$
7	SK2%	$4.70^{f\ (f)}$	$0.079^{h\ (b)}$	$2.8^{d\ (b)}$	$4.0^{d\ (ns)}$	$3.6^{abc\ (bc)}$	$3.5^{abc\ (bc)}$	$4.0^{abc\ (ns)}$	$3.9^{abcd\ (ab)}$	$3.9^{abcd\ (ab)}$	$3.9^{bc\ (b)} - 18^{th}\ (6^{th})$
8.	SK3%	$4.90^{e\ (e)}$	$0.085^{h\ (a)}$	$3.2^{cd\ (ab)}$	$5.7^{abcd\ (ns)}$	$3.7^{abc\ (bc)}$	$3.5^{abc\ (bc)}$	$4.5^{abc\ (ns)}$	$3.6^{cd\ (ab)}$	$2.5^{d\ (b)}$	$5.2^{abc\ (ab)} - 9^{th}\ (3^{rd})$
II	12h-Ft										
9.	CK2%	$3.90^{h\ (a)}$	$0.171^{de\ (b)}$	$4.6^{abcd\ (ab)}$	$5.2^{abcd\ (ab)}$	$4.0^{abc\ (ab)}$	$4.1^{abc\ (ab)}$	$4.60^{abcd\ (abc)}$	$4.0^{abcd\ (ab)}$	$3.6^{bcd\ (ab)}$	$4.5^{abc\ (ab)} - 12^{th}\ (5^{th})$
10.	CK3%	$3.90^{h\ (a)}$	$0.161^{ef\ (c)}$	$4.8^{abcd\ (a)}$	$4.7^{abcd\ (ab)}$	$4.8^{abc\ (ab)}$	$4.9^{abc\ (ab)}$	$3.9^{abc\ (abc)}$	$3.7^{bcd\ (ab)}$	$4.5^{abcd\ (ab)}$	$5.4^{abc\ (ab)} - 7^{th}\ (3^{rd})$
11.	CD2%	$3.90^{h\ (a)}$	$0.137^{fg\ (d)}$	$4.9^{abcd\ (a)}$	$5.7^{abcd\ (a)}$	$4.7^{abc\ (ab)}$	$4.3^{abc\ (ab)}$	$5.4^{abc\ (ab)}$	$5.7^{abc\ (a)}$	$5.0^{abcd\ (ab)}$	$5.8^{abc\ (ab)} - 6^{th}\ (2^{nd})$
12.	CD3%	$3.90^{h\ (a)}$	$0.132^{g\ (e)}$	$4.9^{abcd\ (a)}$	$5.6^{abcd\ (a)}$	$5.4^{abc\ (a)}$	$5.4^{abc\ (a)}$	$5.7^{ab\ (a)}$	$5.5^{abc\ (ab)}$	$5.4^{abc\ (a)}$	$6.3^{abc\ (a)} - 3^{rd}\ (1^{st})$
13.	SD2%	$3.90^{h\ (a)}$	$0.130^{g\ (e)}$	$3.6^{bcd\ (abc)}$	$5.5^{abcd\ (a)}$	$3.7^{abc\ (ab)}$	$3.7^{abc\ (ab)}$	$5.4^{abc\ (ab)}$	$4.4^{abcd\ (ab)}$	$3.9^{abcd\ (ab)}$	$4.0^{abc\ (b)} - 17^{th}\ (7^{th})$
14.	SD3%	$3.90^{h\ (a)}$	$0.131^{g\ (e)}$	$4.5^{abcd\ (ab)}$	$5.9^{abcd\ (a)}$	$4.8^{abc\ (ab)}$	$4.7^{abc\ (ab)}$	$5.7^{ab\ (a)}$	$5.2^{abc\ (ab)}$	$4.9^{abcd\ (ab)}$	$5.1^{abc\ (ab)} - 10^{th}\ (4^{th})$
15.	SK2%	$3.85^{j\ (b)}$	$0.176^{de\ (a)}$	$3.2^{cd\ (bc)}$	$4.8^{abcd\ (ab)}$	$3.5^{bc\ (ab)}$	$3.3^{abc\ (ab)}$	$3.0^{c\ (c)}$	$3.6^{cd\ (b)}$	$3.0^{cd\ (b)}$	$3.7^{bc\ (b)} - 19^{th}\ (8^{th})$
16.	SK3%	$3.80^{j\ (b)}$	$0.175^{de\ (ab)}$	$2.8^{d\ (c)}$	$4.2^{d\ (b)}$	$2.9^{c\ (b)}$	$2.9^{c\ (b)}$	$3.6^{abc\ (bc)}$	$4.0^{abcd\ (ab)}$	$3.3^{cd\ (ab)}$	$4.2^{abc\ (b)} - 16^{th}\ (6^{th})$
III	24h-Ft										
17.	CK2%	$3.70^{k\ (b)}$	$0.203^{b\ (bc)}$	$5.8^{ab\ (ab)}$	$5.7^{abcd\ (abcd)}$	$5.6^{abc\ (ab)}$	$5.3^{abc\ (ns)}$	$5.80^{ab\ (ab)}$	$5.2^{abc\ (abcd)}$	$5.4^{abc\ (abc)}$	$4.4^{abc\ (ab)} - 13^{th}\ (5^{th})$
18.	CK3%	$3.70^{k\ (b)}$	$0.230^{a\ (ab)}$	$4.4^{abcd\ (b)}$	$5.2^{abcd\ (bcd)}$	$4.7^{abc\ (ab)}$	$5.0^{abc\ (ns)}$	$4.4^{abc\ (b)}$	$4.3^{abcd\ (cd)}$	$4.2^{abcd\ (bc)}$	$3.1^{c\ (b)} - 24^{th}\ (8^{th})$
19.	CD2%	$3.70^{k\ (b)}$	$0.193^{cd\ (c)}$	$5.9^{ab\ (ab)}$	$6.6^{ab\ (ab)}$	$6.0^{ab\ (a)}$	$5.3^{abc\ (ns)}$	$5.6^{abc\ (ab)}$	$6.1^{ab\ (ab)}$	$6.4^{a\ (a)}$	$6.6^{ab\ (a)} - 2^{nd}\ (1^{st})$
20.	CD3%	$3.70^{k\ (b)}$	$0.197^{cd\ (c)}$	$6.4^{a\ (a)}$	$6.5^{abc\ (abc)}$	$5.9^{ab\ (a)}$	$5.2^{abc\ (ns)}$	$5.1^{abc\ (ab)}$	$5.6^{abc\ (abc)}$	$6.20^{a\ (a)}$	$5.6^{abc\ (ab)} - 8^{th}\ (3^{rd})$
21.	SD2%	$3.90^{h\ (a)}$	$0.210^{c\ (abc)}$	$5.5^{abc\ (ab)}$	$6.8^{a\ (a)}$	$4.8^{abc\ (ab)}$	$4.8^{abc\ (ns)}$	$6.1^{a\ (a)}$	$6.3^{a\ (a)}$	$5.9^{ab\ (ab)}$	$6.2^{abc\ (a)} - 4^{th}\ (2^{nd})$
22.	SD3%	$3.70^{k\ (b)}$	$0.203^{c\ (bc)}$	$6.2^{a\ (ab)}$	$5.9^{abcd\ (abcd)}$	$5.2^{abc\ (ab)}$	$4.8^{abc\ (ns)}$	$6.1^{a\ (a)}$	$6.3^{a\ (a)}$	$5.5^{abc\ (abc)}$	$4.8^{abc\ (ab)} - 11^{th}\ (4^{th})$
23.	SK2%	$3.60^{m\ (c)}$	$0.229^{b\ (ab)}$	$5.1^{abcd\ (ab)}$	$5.1^{abcd\ (cd)}$	$3.8^{abc\ (b)}$	$4.0^{abc\ (ns)}$	$4.0^{abc\ (ab)}$	$4.5^{abcd\ (bcd)}$	$3.9^{abcd\ (b)}$	$3.1^{c\ (b)} - 24^{th}\ (8^{th})$
24.	SK3%	$3.60^{m\ (c)}$	$0.237^{b\ (a)}$	$4.7^{abcd\ (ab)}$	$4.8^{abcd\ (d)}$	$4.0^{abc\ (ab)}$	$4.5^{abc\ (ns)}$	$4.2^{abc\ (ab)}$	$3.8^{bcd\ (d)}$	$4.0^{abcd\ (b)}$	$3.1^{c\ (b)} - 24^{th}\ (8^{th})$

differences were observed on the pH, titrable acidity and other sensory values of the various *kindirmo* treatments ($P \leq 0.05$). It was observed that inoculum volumes (2% & 3%) had no significant effect for most of the factors measured. For example, using *kindirmo* as starter culture, whether from whole cow milk (CK2% & CK3%) or cow-soymilk (SK2% & SK3%) as fermentation substrate, no significant difference ($P \geq 0.05$) was observed for pH, titrable acidity and all sensory factors between the *kindirmo* samples in each case. But where DVI was used as starter culture in producing *kindirmo*, significant differences ($P \leq 0.05$) was only observed for pH or only for titrable acidity when whole cow milk (CD2% & CD3%) or cow-soymilk (SK2% & SK3%) respectively was used as fermentation substrate. Milk type used in *kindirmo* production affected the quality of *kindirmo* produced. For example, CK2% differs from SK2% in pH, titrable acidity and flavour. Also CK3% and SK3% only have significant difference in titrable acidity ($P \leq 0.05$). Similarly, kindirmo treatments of CD2% & SD2% on one hand and that of CD3% & SD3% on the other hand, differ from each other either only in pH or in titrable acidity ($P \leq 0.05$).

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Still at 5h fermentation time, the type of starter culture used in producing *kindirmo* had similar degree of effects on their quality as the effect of type of milk. For example, CK2% and CD2% on one hand and between CK3% and CD3% on the other hand, their *kindirmo* differ in each case only in pH and titrable acidity ($P \leq 0.05$). The same trend is observed between SK2% and SD2% on one hand and between SK3% and SD3% on the other hand. Comments of the taste panelists on the eight *kindirmo* treatments of 5h fermentation did show that kindirmo from both cow milk and soymilk as well as when kindirmo and commercial starter culture were used were generally acceptable. However, there were preference for CD3% and SK3% kindirmo treatments while SK2% treatment was among the least preferred. Some excerpts in the taste panelists of kindirmo of 5h fermentation are given below:

- "Samples DD (i.e. CD3%) and FF (i.e. SK3%) have excellent taste and sweetness"
- "The best quality is DD (i.e. CD3%) while the least quality is EE (i.e. SK2%)"
- DD is preferred but you need to improve on your texture"
- "DD is very good and the texture should just be improved a little"
- "Sample DD has the best quality among all but the texture has to be improved a little to make it thicker"
- "Samples AA (CK2%), BB (CK3%), CC (CD2%) and GG (SD2%) are good, GG is the best, while EE (SK2%), FF (SK3%) and HH (SD3%) are something else"

Despite the above comments, at 5h fermentation, use of *kindirmo* as starter culture produced the first three best *kindirmo* samples based on numerical ranking values (Table 3). The pH, titrable acidity and sensory values of *kindirmo* of different treatments and fermented for 12h showed significant differences ($P \leq 0.05$). Except for titrable acidity, no significant difference is observed among *kindirmo* samples produced from whole cow milk, irrespective of the starter culture type. But for *kindirmo* made from cow – soymilk composite significant differences were observed for all the parameters ($P \leq 0.05$). Also the effect of inoculum volume on *kindirmo* quality follows the same trend like in milk type.

The effect of starter culture type on *kindirmo* varied according to the milk type and inoculum volume. For example, using whole cow milk as fermentation substrate and at 3% inoculum volume, no significant difference ($P \geq 0.05$) was observed in all parameters for *kindirmo* produced using DVI on one hand or *kindirmo* on the other hand as starter culture. The same trend is observed at 2% inoculum level (Also using whole cow milk) excepting titrable acidity where significant difference is observed between their *kindirmo*. However, the use of cow – soymilk gave somewhat different result. For example at 2% inoculum level, only the pH, titrable acidity and the sensory factor of texture showed differences in these qualities of *kindirmo*. Similarly at 3% inoculum volume, the pH, titrable acidity, texture, colour and flavour showed differences in their *kindirmo* quality ($P \leq 0.05$).

Like in 5h fermentation, taste panelists comments on the kindirmo treatments at 12h fermentation did give greater approval of CD3% and SK3% kindirmo treatments while SD2% and SK2% kindirmo treatments had lower approval ratings. Some of their comments include:

- "Flavour of sample of GG (SK2%) is very sharp and so will not be advised to be used in making yoghurt for commercial consumption"
- "The flavour of EE (SD2%) is not pleasing because it doesn't have yoghurt-like flavour, so also with the taste"
- "Sample HH (SK3%) is quite pleasing to me because I like its sweetness and mouthfeel"
- "Sample BB (CK3%) has good quality but needed some attention on its flavour, taste, texture and mouthfeel"
- "Sample HH (SK3%) and GG (SK2%) has high acidity and should be looked into"
- "Sample HH (SK3%) is over fermented"
- The sweetness of sample DD (CD3%) is very good, while the taste of HH (SK3%) is not good"
- "The flavour of HH (SK3%) is okay. BB (CK3%) is most preferred"
- "Sample CC (CD2%) is the most pleasing sample because of its taste and colour"
- "DD (CD3%) has the best quality while AA (CK2%) is displeasing to me"

The above comments does prove that use of DVI as starter culture and use of whole cow milk as fermentation substrate results to a better desired *kindirmo*. But that the *kindirmo* from cow – soymilk composite (SD2%) is numerically rated 4th does suggest that this level of substitution (20%) of cow milk with soymilk is acceptable. Secondly and perhaps more important is the fact that except *kindirmo* made from CD3% that not much statistical difference exist between *kindirmo* made from whole cow milk and that from cow – soymilk composite when fermented for 12h. Table 3 also shows the pH, titrable acidity and sensory values of *kindirmo* fermented for 24h. Except for sensory factor of sweetness, significant differences ($P \leq 0.05$) were observed on all the other attributes of *kindirmo* with different treatments. Appreciable reduction in the pH of all the *kindirmo* was observed. Also pH of all the

kindirmo samples excepting that made from SK2% and SK3% were significantly different from each other (P = 0.05). In addition, apart from kindirmo of treatments CK2% and CK3% that differ only in titrable acidity values), percentage inoculum volume had no significant difference on the pH and sensory factors of *kindirmo* samples made from the same starter culture and milk type and fermented for 24h (P = 0.05).

The comments of the taste panelists on the degree of likeness and dislike of the various *kindirmo* treatments showed that kindirmo produced using commercial (DVI) starter culture than the use of kindirmo of 24h age as starter culture. Some excerpts of their comments included:

- "Sample CC (CD2%) is the best in good quality parameters"
- "I like the taste and sweetness of CC (CD2%) much more than that of DD (CD3%)"
- "CC (CD2%) produced pleasant taste, flavour, texture and general acceptability based on its lactic acid content"
- "The taste of EE (SK2%) and FF (SK3%) are horrible since they are too acidic for consumption"
- CC (CD2%), GG (SD2%) and HH (SD3%) is the order of appeal"

Based on ranking values that range from 8 (1st) to 1 (8th), *kindirmo* fermented for 24h with CK2%, SK2% and SK3% were rated less than 4.0. Also the three of them had no statistical difference from each other. Another observation is that at 24h of fermentation, only the *kindirmo* using DVI as starter culture irrespective of milk substrate type were among these first four that were rated above 4.0. Considering all the 24 *kindirmo* treatments irrespective of fermentation time, it was observed that as from 12hrs of fermentation, the rate of pH decrease was much reduced. This most likely signified depletion of fermentation substrate or loss of activity of the fermenting microorganisms or both. Also fermentation time was seen to have varied effects on the different *kindirmo* treatments. For example, *kindirmo* made from CK2% only differed in their pH and titrable acidity but there is no significant difference among them on all the sensory factors (P = 0.05). The same is also true of *kindirmo* made from treatments CK3%, SK2%, SK3%, CD2% and CD3%. The implication is that fermentation time has not significantly affected the organoleptic acceptability of each *kindirmo* treatment with different fermentation times. It is also important to remark that in the numerical ranking of the organoleptic acceptability of 24 *kindirmo* treatments, kindirmo made from different milk type, starter culture and fermentation times were among the first 10 most acceptable *kindirmo* treatments.

Conclusion

As in the first research (Effects of processing conditions on the quality of kindirmo made from whole cow milk and cow–soymilk mixtures - I), it was also observed in this research (Effects of processing conditions on the quality of kindirmo made from whole cow milk and cow–soymilk mixtures - II) that the most acceptable *kindirmo* treatments criss-crossed all treatment factors. They include inoculum volume ratios (2% and 3%) and fermentation times (5h, 12h and 24h). Others are starter culture type (DVI & *Kindirmo*) and milk type (whole cow milk & cow-soymilk composite). It is deduced therefore that the two inoculum volume ratios used are all acceptable. Also 20% cow milk substitution with soymilk is acceptable to the consumers in *kindirmo* production. In addition, all the three fermentation times used could produce desired *kindirmo* products depending on the type of milk substrate and starter culture used and the starter culture inoculum volume to milk substrate ratio.

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