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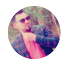

Plant Archives Vol. 20, Supplement 1, 2020 pp. 3250-3254 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

STUDY AND EVALUATION OF YOGHURT PRODUCTS PREPARED FROM VARIOUS COMMERCIAL STARTER CULTURES

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Abstract

Four various commercial starter cultures in this study were used. In fact, BIENA, CHR HANSEN, DIPROX and SACO are widely utilized as starter cultures for fermentation in food industries, especially dairy products. On the other hand, yoghurt products and fresh milk were analyzed for chemical properties such as moisture content, total solids content, pH value and acidity. However, sensory properties of yoghurt products prepared from different starter cultures were evaluated. Furthermore, significant differences between products were investigated in each sensory attributes such as taste, flavor, total acceptability and texture. Explanation of yoghurt products prepared from different sources was elucidated by FTIR spectroscopy. All yoghurt products exhibited similar functional groups. Moreover, the spectrum of yoghurt produced from CHR HANSEN is roughly similar to that of a SACO. Based on these data, we concluded that CHR HANSEN is the most important starter cultures in this study. On the other words, the most important desired features for CHR HANSEN are its taste; flavor, overall acceptability and texture (see table 2).

Key words: Raw milk, starter cultures, Yogurt, FTIR spectra.

Introduction

Yogurt can be identified as a fermented product of raw milk by bacteria fermentation (Rahman *et al.,* 1999). Furthermore, dairy products as yoghurt are one of the most commonly utilized fermented milk products in many countries. In practical, yoghurt can be classified into two different groups namely, standard culture yoghurt and bio-or probiotic yoghurt (Weerathilake *et al.,* 2014). Generally, yoghurt starter culture is mostly prepared by lactic acid fermentation of pasteurized cow's milk using different strains as *Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus* etc. (Yilmaz-Ersanand Kurdal, 2014). Dabija *et al.,* (2018) studied the Influence of different commercial starter cultures on quality of yoghurt extensively. Many studies reported that the starter culture play an important role indetermination of the overall quality of yogurt (Dabija *et al.,*2018). On the other hand, Soomro and Masud (2008) isolated the yoghurt starter culture from indigenous strains of *Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus*. Moreover, there are new strains of lactic acid bacteria such as *Lactobacillus delbrueckii*s ubsp. *bulgaricus* strains were also isolated from various fermented milk products (Xanthopoulous *et al.,* 2001). Several researchers have been studied the quality evaluation of yoghurt produced commercially and locally. The total solids (TS) determinations were performed by Reh and Gerber (2003) in dairy products using the microwave oven method. The pH of raw milk is roughly 6.6 (Al-Hilphy *et al.,* 2017).

FTIR-spectroscopy has been allowed for the monitoring of structural information such as polymers (Mohsin *et al.,* 2018; Mohsin *et al.,* 2019; Mohsin *et al.,* 2020) and also to identify functional groups in bacteria (Amiel *et al.,* 2001). Infrared spectroscopy (IR) can be characterized of molecular structure of food (Mohsin *et al.,* 2019). An FTIR spectrum was used to identify the chemical properties of starter culture fermented sweet potato flour (Ajayi *et al.,* 2019).Several popular types of yoghurt products (produced commercially from different starters) available in the market are described in most

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studies. This paper aimed at investigating the specific fingerprints for the yoghurt products prepared from different starter cultures using Fourier transform infrared (FTIR) spectroscopy and also examination and comparison of chemical compounds present in the yoghurt products and raw milk.

Materials and Methods

Starter cultures

Cow milk was provided by the College of Agriculture, University of Misan, BIENA was produced from Canada, CHR HANSEN was produced from Copenhagen, Denmark, DI PROX was produced from French, and SACO was produced from Italy.

Preparation of sample

The yoghurt was produced according to the method described by Tamine and Robinson (1999) with some modifications. Fresh milk was provided by the College of Agriculture, University of Misan. The raw cow's milk was pasteurized at 90°C for 5 min, and the pasteurized products were cooled to 43°C. Moreover, the products were inoculated with high concentrations of reactivated starter culture (each the four starter cultures contain *Lactobacillus bulgaricus* and *Streptococcus thermophilus*). However, fermentation process was maintained at 45ºC for 4huntil the pH level decreased to 4.5 and then the incubation was done. Finally, the yogurt product was cooled at 4°C and stored at the same temperature.

Measurement of acidity

Examination of titratable Acidity was measured by AOAC procedures (1975).

Measurement of pH

The pH of yoghurt and raw milk was recorded by using a digital pH meter (Jenway 3505).

Determination of moistures content

The moisture content of the yogurt product and raw milk was determined using a digital moisture analyzer (WBA-110M).

Determination of total solids content

The total solids content of a yoghurt and raw milk recalculated through the following equation: 100 - moisture content

Fourier Transform Infrared (FTIR) of starter cultures

FTIR measurements were performed according to Mohsin *et al.*, (2019) with some modifications using a Shimaduz 8400S. MIR-spectra were collected at a resolution of 4 cm^{-1} in the range of 600- 4000cm^{-1}. The measurements were done directly in the yoghurt products.

Sensory evaluation

The products were evaluated by eight judges using a sensory rating degree of 1-10.

Results and Discussion

FTIR spectra of starter cultures

Fig. 1 shows the FTIR spectra of yoghurt products prepared from different starter cultures. Yoghurts have been shown to possess broad peak stretching vibration of the OH group in the region of 3335 - 3284cm^{-1} due to the amount of hydroxyl groups in lactose. All samples show the absence of NH^+or NH_2 stretching at 3082 cm^{-1} because it is hidden under the OH-shoulder (Mohsin *et al.*, 2018; Mohsin *et al.*, 2019; Mohsin *et al.*, 2020). Additionally, the group of CH_3 and CH_2 stretching peaks which is absorbed in the region of 2865 and 2950 cm^{-1} respectively were observed. The regions between (1600-1690) cm^{-1} confirm the existence of δ (N-H) or μ (C-N) group for all samples as sharp peak. The IR spectrum of yoghurt produced from BIENA is roughly similar to the spectrum of DI PROX 2 in the absorption of the δ (N-H) or μ (C-N), μ (C-N), μ (C-N) and δ (CH) which is absorbance at 1560-1541,1508,1473 and 1458 cm^{-1} respectively.

However, the spectrum of yoghurt produced from CHR HANSEN was also very similar to that of a SACO. On the other hand, no absorption band which is characteristic of carbonyl or carboxyl group at region 1750-1700cm^{-1} was observed. Perhaps color of samples due to disappear of C=O stretching. A band can be assigned as COO^-stretching vibration at 1627 cm^{-1}. Moreover, stretching band of the carboxylate (COO^-) absorption are overlapped with the (C=O, C=C, C=N) group at 1627cm^{-1} due to the amino acid is in a zwitterion (Mohsin *et al.*, 2019). Finally, all types of yoghurts show the presence of the hydroxyl group ν (OH), ν (CH_3), ν (CH_2), ν(C=O, C=N, C=C),ν (COO^-), δ (N-H),μ (C-N), ν(C-O) and δ (C-H). FTIR spectra does not detect the presence of NH^+ and C=O stretching at regions 3082 cm^{-1} and 1750 cm^{-1} respectively.

Total solids content (TS)

Total solids content of the yoghurt sample and cow milk are observed in (Table 1). However, chemical composition of fresh milk is very similar to that of the yoghurt. Changes in pH value and acidity of yoghurt sample are observed (see table 2). Moreover, the difference between the yoghurt and fresh milk in pH is

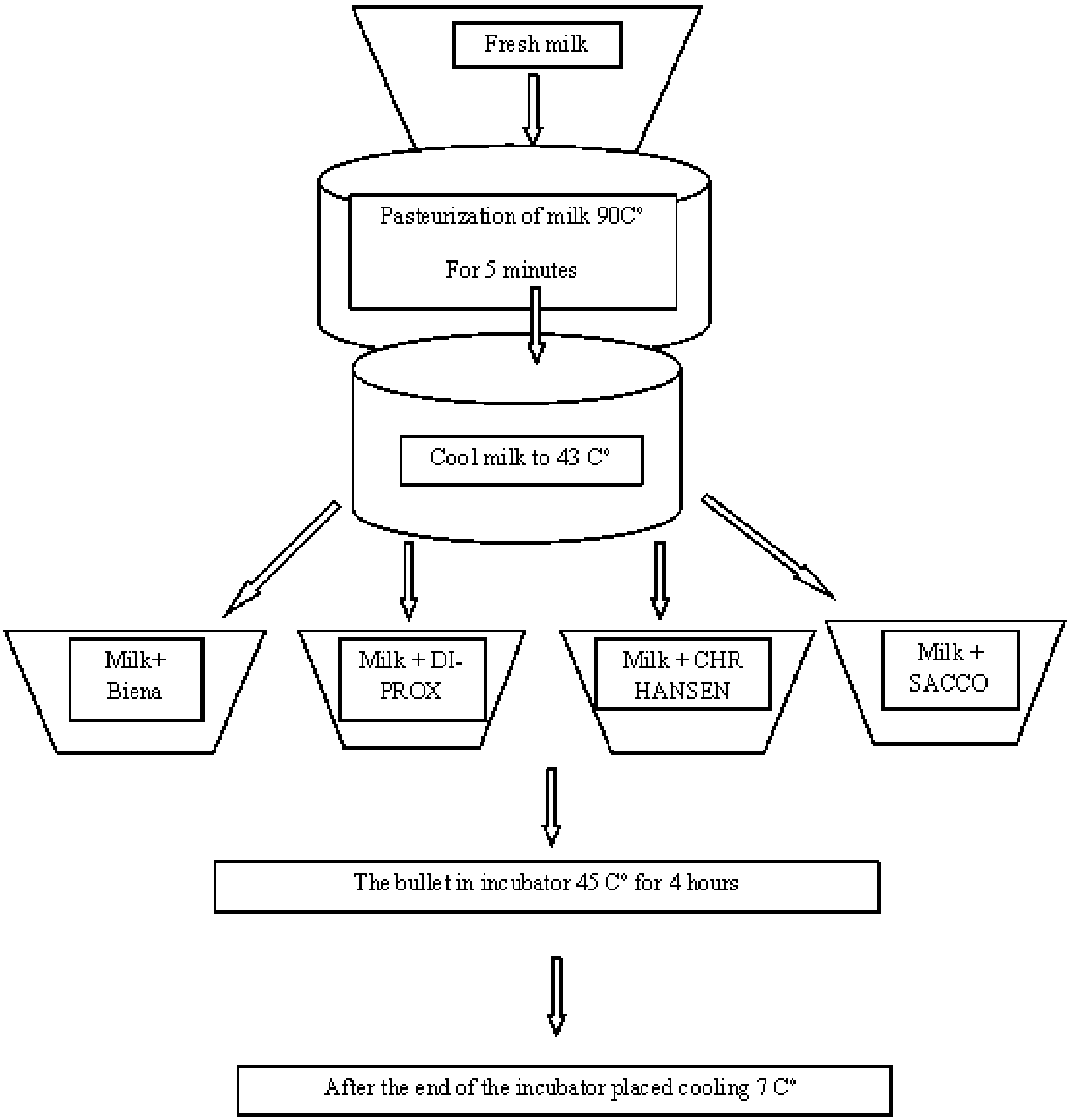

Fig. 1: Method for the production of yoghurt (based on Tamine and Robinson, 1999).

investigated. Generally, the chemical composition of all yoghurts produced from different starters is similar.

Sensory analyses

Effect of yoghurt products prepared from different starter cultures on the sensory features was studied. Sensory evaluation was achieved by eight judges (for evaluating product acceptability) with sensory experience evaluated the yoghurt products (laboratory technicians from College of Agriculture, University of Misan) for taste, flavor, texture and overall acceptability. In practical, sensory properties were used to evaluate distinctions among the four sorts of yoghurt products. However, sensory analyses of different yoghurt products included evaluation of taste, flavor, overall acceptability and texture (see table 3). Additionally, the average score of sensory properties of yoghurt produced from CHR- HANSEN is higher in comparison to other yoghurts. Furthermore, the mean score of sensory attributes as overall acceptability, flavor, taste and texture of yoghurt samples as affected by total solids content (TS) are summarized in table 3. It is suggested that the chemical composition of yoghurt

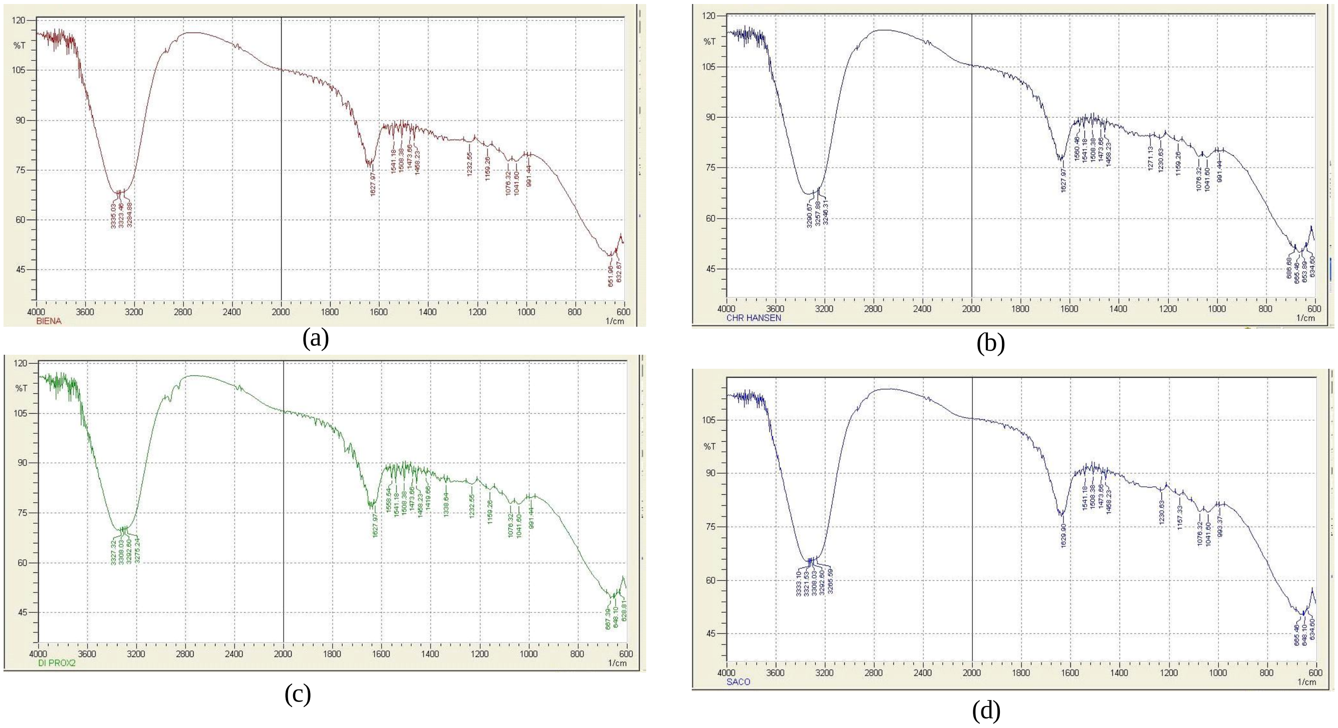

Fig. 2: FTIR spectra of yoghurt products prepared from different starter cultures: (a) BIENA, (b) CHR HANSEN, (c) DI PROX 2, (d) SACO.

Table 1: FTIR band assignment of yoghurt products prepared from different sources according to (Mohsin et al, 2018; Mohsin et al, 2019; Mohsin et al, 2020). Existent: "+", intensity: b-broad, sh-sharp, m-middle, w-weak.

Position / cm^{-1}	Modes	BIENA	CHR HANSEN	DI PROX 2	SACO
3335-3284	$O\text{-}H_{stretching}$	+b	+b	b+	b+
~2965	$CH_{3stretching}$	+m	+w	m+	w+
~2950	$CH_{2stretching}$	+m	w+	m+	w+
1627	$(C{=}O,C{=}C,C{=}N)_{stretching}$	+b	+b	b+	b+
1560-1541	$N\text{-}H_{deformation}$ or $C\text{-}N_{stretching}$	+sh	+w	sh+	w+
1508	$C\text{-}N_{stretching}$	+sh	w+	sh+	w+
1473	$CH_{bending}$	sh+	w+	sh+	w+
1458	$CH_{bending}$	sh+	w+	sh+	w+
1338	$C\text{-}N_{stretching}$	w+	w+	w+	w+
1271	$C\text{-}N_{stretching}$	m+	m+	m+	m+
1232	$C\text{-}N_{stretching}$	m+	m+	m+	m+
1160	$C\text{-}O_{stretching}$	m+	m+	m+	m+
1041-1076	$C\text{-}O_{stretching}$	m+	m+	m+	m+
991	$C\text{-}H_{bending}$	w+	w+	w+	w+
686-634	$C\text{-}H_{bending}$	+b	+b	b+	b+

product play an important role in the appearance of sensory qualities. In fact, the yoghurt prepared from CHR-HANSEN appears the highest levels of sensory properties (higher score) in comparison to other products. All sensory analyses were done in triplicate.

The best starter culture has been shown to possess more sensory attributes is used to describe taste, texture, total acceptability and flavor. To characterize the sensory influence of different starters can be demonstrated in Fig. 3 as following: 29.23% CHR-HANSEN, 26.15% SACCO, and 23.08 DI-PROX and 21.54% BIENA. In general, the sensory properties of yoghurt produced from CHR-HANSEN are higher than that of SACCO. On the other words, the results indicated that the CHR- HANSEN is the best starter culture for fermentation. Dabija et al (2018) have been concluded that the selection criteria for the best starter culture that could be applied in the industrial process for yogurt and other dairy products.

Conclusion

The sensory properties and chemical compounds of yoghurt were compared with fresh milk. Total solids content (TS) of cow milk is very similar to that of the yoghurt samples. All types of yoghurt products prepared from different starter cultures exhibited the presence of ν (OH), ν (CH_3), ν (CH_2), ν(C=O, C=N, C=C), ν (COO^-), δ (N-H), μ (C-N), ν(C-O) and δ (C-H). On the other

Table 2: The Chemical composition of raw milk and yoghurt.

Acidity	pH	Solids%	Moisture%	Samples
0.16	6.5	12	88	Cow milk
0.91	4.5	12	88	Yoghurt products*

*The chemical composition of all yoghurt products is fully similar.

Table 3: Quality judging standards for yoghurt samples produced using different starters. (Degree is from 10).

Overall acceptability	Texture	Flavor	Taste	Type of starter culture
8.5	8.5	8.5	8	SACCO
9.5	9.5	9	9.5	CHR- HANSEN
7.5	8	7	7.5	DI-PROX
7	7.5	7	7	BIENA

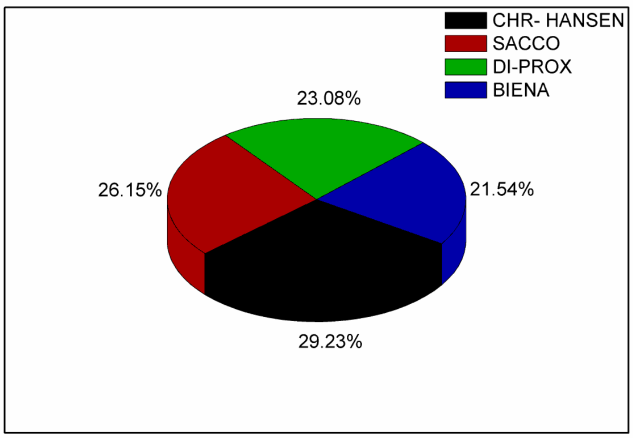

Fig. 3: Distribution of the sensory attributes in the different yoghurt products as a percentage.

hand, sensory analyses of various yoghurt samples included evaluation of taste, flavor, and texture. From these results, it could be concluded that the CHR HANSEN is the best starter culture could be applied in the industrial process for yoghurt.

Acknowledgements

The authors are grateful to Misan Dairy Factory for technical assistance.

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