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Acetaldehyde Production Rate in Yoghurt Made from Ultrafiltered Skim Milk

AINAZ ALIZADEH†, MOHAMMAD REZA EHSANI‡ and AZIZ HOMAYOUNI*
Department of Food Science and Technology, Faculty of Health and Nutrition
Tabriz University of Medical Sciences, Tabriz, Iran
Fax: (98)(411)3340634; Tel: (98)(411)3357581
E-mail: homayounia@tbzmed.ac.ir

The chemical composition, acetaldehyde content and sensory attributes of yoghurts produced from ultrafiltered milk retentates and normal yoghurt made with skim milk powder were studied and compared in triplicate. Ultra filtrated yoghurts had more content of acetaldehyde, protein, lactic acid and total solid than control but lactose content and syneresis were at lower level. The amount of produced acetaldehyde was dependent to the protein amount. Acetaldehyde production was increased by increasing the protein content. The quantity of acetaldehyde decreased during the storage of yoghurt. Ultra filtrated yoghurts showed higher sensory scores than control. Yoghurt made from ultra filtrated retentate with 13.5 total solid and 5.3 % protein got the highest rating for all sensory properties and was comparable with one of the most acceptable yoghurts produced in Iran.

Key Words: Acetaldehyde, Ultrafiltration, Yoghurt.

INTRODUCTION

The formulation of products such as yoghurt with optimum consistency and stability to syneresis is a main concern to dairy industry. Factors influencing yoghurt texture and syneresis include total solid (TS), protein, salts, homogenization, type of culture, acidity and heat pre-treatment. The solid content of milk can be increased by applying evaporation of treated milk, addition of skim milk powder (SMP) or protein concentrates and concentrating the milk by ultra-filtration (UF) or reverse osmosis (RO)[1]. Addition of milk powder or whey is a general method for increasing the total solids of yoghurt. However, the thermal degradation of proteins and vitamins through heat treatment of milk can be very important in these cases, reducing the nutritional value of yoghurt[2]. Also milk powder itself is a product witch has undergone extremely harsh thermal processing that alters

†Department of Food Science and Technology, Faculty of Agriculture Sciences and Natural Resources, Islamic Azad University, Tabriz Branch, Tabriz, Iran.

‡Department of Food Science and Technology, Faculty of Biosystem Engineering, Campus of Agriculture and Natural Resources, The University of Tehran, Tehran, Iran.

some of its constituents. An alternative to obtain yoghurt with higher nutritional value is to increase the total solids in milk by means of membrane technology[3].

The industrial scale production of yoghurt from milk concentrated by ultra filtrated or reverse osmosis has been reported by Tamime and Robinson[4]. Whole milk concentrated by ultra filtrated to 18-20 % total solid produced a smooth and creamy yoghurt with a typical acid flavour that homogenization was not required. Skimmed milk concentrated by ultra filtrated to 13 % total solid was suitable for yoghurt making[4].

Use of membrane technologies for the concentration of milk for production of cultured dairy products has been documented in several reports but most of them were focussed on physical properties of ultra filtrated yoghurts that are improved by the application of these technique. It is important to understand the effect of membrane processing on flavour and sensory properties of ultra filtrated yoghurts. The present study was carried out to compare the chemical and sensory attributes of experimental yoghurts made from ultra filtrated retentates and normal yoghurts produced by adding skim milk powder (SMP) to initial milk as control. Also acetaldehyde content of samples was compared with each others as one of the most important factors of yoghurt flavour.

EXPERIMENTAL

Experiments were done in triplicate in dairy pilot plant of Department of Food Science and Technology, Faculty of Biosystem Engineering, Campus of Agriculture and Natural Resources, University of Tehran, Tehran, Iran.

Ultrafiltration: Pasteurized milk (with 1.8 % fat content) was ultrafiltered with a poly ether sulphone spiral wound membrane (nominal molecular weight cut-off 20,000 D) at 50 ºC. Retentates were obtained form the system at three steps with attention to their total solid contents. Samples were named A, B and C, respectively.

Fermentation step: When the necessary concentration was reached, the samples were heated at 78 ºC for 1 min in stainless steel buckets with stirring continued during cooling to 42 ºC. These samples were inoculated with the starter culture, code YC-350 from CHR-Hansen (Denmark) at a level of 0.4 % (v/v) (Nu-trish, 2004, Hansen) and dispensed into yoghurt pots of 200 mL. The containers were then incubated at 45 ºC until the pH was reached to desired value. The pH of the samples was recorded during incubation using a pH-meter. After incubation, the samples were transferred to a refrigerator at 4 ºC. A control sample was prepared with pasteurized milk (with 3.23 % fat content) and addition of 2 % SMP (w/v) and named as D sample. Another control sample (with 3 % fat content) was obtained from Iranian market for comparison of acetaldehyde content and sensory analysis and named as E sample.

Analysis: Total solid, fat, protein and lactose content of retentates were determined by a Milko-Scan (133 B N.FOSS Electric, Denmark). pH and titrable acidity of yoghurt were measured according to AOAC methods[5]. Acetaldehyde was extracted by distillation of yoghurts and detected by gas chromatography using a Philips PU 4410 (packed column, FID detector, helium as carrier gas and temperature programming procedure) at 1 and 14 days of storage. Panel taste and rating scores analysis was used to assess the sensory properties of yoghurts by employing 50 untrained panelists at the day 14 of storage.

Statistical analysis: Samples for chemical analysis were taken in triple batches and the results were assessed by SAS software version 8. Sensory data were subjected to analysis of Friedman.

RESULTS AND DISCUSSION

The ultra filtration experiments were aimed at providing membrane retentates with solid levels at 11.93, 13.68 and 16.18 % for subsequent production of yoghurt. The apparent protein content of retentates increased from 3.07 % in pasteurized milk to 6.80 % in the most concentrated retentate having total solids of 16 %. Lactose was slightly decreased, fat content increased from 1.80 to 3.74 % and also total solid increased from 10.24 to 16.18 % in the final received sample (C) (Table-1). Acidity was detected for all the samples during storage (Fig. 1).

TABLE-1
COMPOSITIONS OF PASTEURIZED MILK, UF RETENTATES, PERMEATE AND CONTROL SAMPLE

Sample	Fat	Protein	Lactose	TS	SNF
Pasteurized milk	1.80±0.01	3.07±0.01	4.78±0.02	10.24±0.03	8.44±0.03
A (Cf = 1.5)	2.46±0.01	4.28±0.02	4.62±0.01	11.93±0.01	9.46±0.02
B (Cf = 1.8)	2.91±0.07	5.26±0.01	4.55±0.06	13.68±0.02	10.31±0.09
C (Cf = 2.2)	3.74±0.01	6.80±0.11	4.47±0.01	16.18±0.03	12.48±0.02
D (Control)	3.23±0.03	3.06±0.01	4.92±0.05	11.80±0.03	8.57±0.07
Permeate	0.90±0.01	0.13±0.01	4.07±0.01	4.83±0.02	3.77±0.02

As it was shown in Fig. 1 the acidity has increased for all the samples at the day one of storage during fermentation and followed within storage period. Also, the acidity of UF yoghurts are always more than control (D) thatis because of more protein content of these samples and accordingly more buffering capacity that permit more acid production. Acetaldehyde has been detected and compared as one of the major flavour compounds in yoghurt for all the samples (Fig. 2).

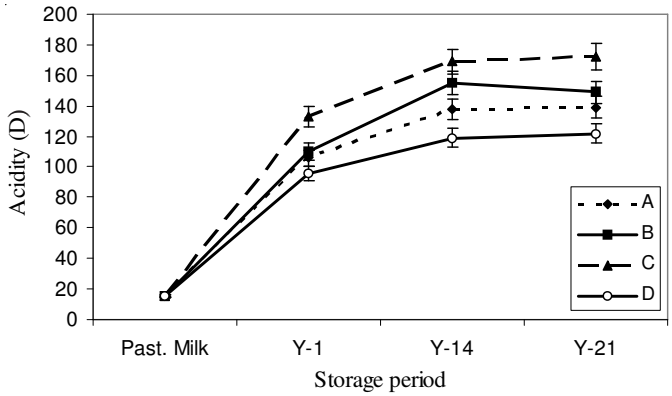

Fig. 1. Acidity changes during storage period (1, 14 and 21d) of ultrafiltered samples and control. Error bars indicate the standard deviation

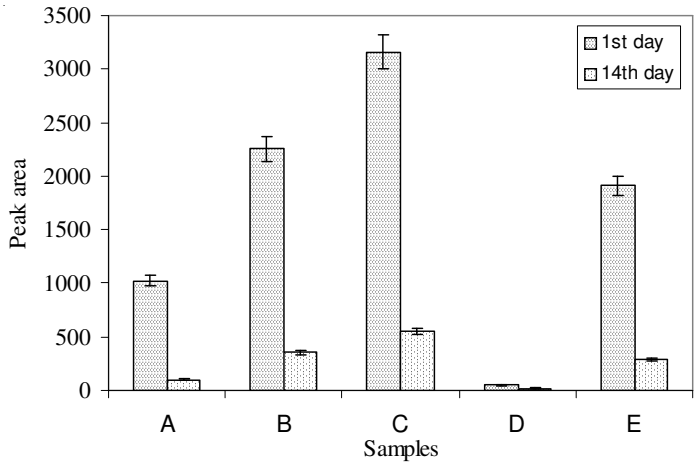

Fig. 2. Acetaldehyde content of different samples measured by GC at days 1 and 14 of storage. Error bars indicate the standard deviation

Higher content of protein causes increased amount of acetaldehyde for the UF yoghurts than control. Thus despite the lower lactose content of UF retentates, acetaldehyde production by starter bacteria was not impaired. Acetaldehyde and other carbonyl flavour compounds can be produced by more than one metabolic pathway and from various precursors including lactose, valine, pyruvate, threonin and acetyl phosphate that threonin is the most important way of its production[4]. The acetaldehyde content of yoghurts decreased with storage confirming the findings of Biliaderis *et al.*[1]. However, at all total solid levels or protein levels the UF yoghurts showed more amounts of acetaldehyde compared with control. The mean rating scores for sensory attributes of yoghurts with respect to the protein content are shown (Fig. 3).

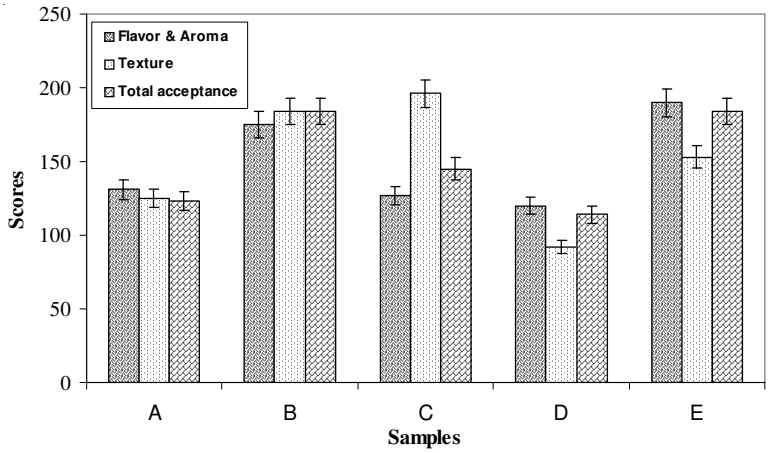

Fig. 3. Mean rating scores for sensory properties of yoghurt sample. Error bars indicate the standard deviation

In general, sensory analysis revealed differences between samples that UF yoghurts had higher rating scores comparing with control (D). Also B sample (Pr 5.3 %, TS 13.5 %) was comparable with one of the most popular yoghurts in Iranian market. Although C sample had the most amounts of protein, TS and acetaldehyde content, it was not accepted by panelists because of its so firm texture. All UF yoghurts were much resistant to syneresis because of the more protein and acid content comparing with control. Also syneresis decreased during storage period.

Conclusion

The results of chemical analysis showed that protein increase of the ultrafiltered samples causes more but slow acid production because of the more buffering capacity of these samples. Also more protein content showed more acetaldehyde production that decreases during storage period. Sensory analysis confirms the chemical analysis results and finally concentrated milk to 13.5 % solids by UF process (B sample) can produce yoghurt with good acceptability.

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