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Extended Abstract

Investigation of the Effect of Starter type and Formulation on Physicochemical and Sensory Properties of Concentrated Yoghurt Using Mixture Design and Two-stage Clustering Method

Hassan Rashidi[1]*, Morteza Kashaninejad[2], Marzieh Bolandy[3], Samane Ghaffary[4]

1- Associate Professor, Khorasan Razavi Agricultural and Natural Resources Research and Education Center, AREEO, Mashhad, Iran
* Corresponding author (h.rashidi@areeo.ac.ir)
2- PhD. Student, Department of Food Science and Technology, Ferdowsi University of Mashhad (FUM), Mashhad, Iran
3- Associate Professor, Department of Food Science and Technology, Damghan Branch, Islamic Azad University, Damghan, Iran
4- MSc. Graduate, Department of Food Science and Technology, Damghan Branch, Islamic Azad University, Damghan, Iran

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Abstract

In this study, the effect of starter type (probiotic and non-probiotic), milk (58 to 80%), cream (1 to 33%), whey powder (3 to 7%) and milk protein concentrate (6 to 12%) on acidity, pH, viscosity and sensory properties (flavor, color, texture and overall acceptance) of yogurt were evaluated using mixture design and then treatments were clustered and analyzed using two-stage clustering. The results showed that the linear effects of treatments (milk, cream, whey powder and protein concentrate) on all responses of the samples were significant, so increasing milk cream led to an increase in pH, viscosity, texture, color and flavor and overall acceptance and decreased acidity of the samples. Increasing whey powder and milk protein concentrate also led to increasing acidity and decreasing pH, viscosity, texture, color and overall acceptance of the samples. The linear effect of the starter type had no significant effect on the responses of the samples. Two-stage data clustering also divided the treatments of this study into two separate clusters and showed that whey powder and milk protein concentrate are not suitable substitutes for fat.

Keywords: Concentrated yoghurt, Milk protein concentrate, Mixture design, Probiotics, Two-stage clustering

Introduction

The composition of the milk components used to produce the labane (concentrated yoghurt) produced by wheyless process is very important for the final quality of the product. Also, by literature review and focusing on the research, it can be seen that although most of the studies about yogurt have focused on the effect of the type of starter or the substitution effect of different compounds on its physicochemical and sensory properties; however, the effect of starter type and formulation on physicochemical and sensory properties of concentrated yoghurt has not been paid much attention and, although in most studies, the significance of independent variables have been investigated using the results of analysis of variance, it seems that clustering of process treatments can be a good method for better understanding the different formulas of the

concentrated yoghurt with the desired features. Banykó & Vyletělová (2009) used clustering analysis to evaluate the source of Bacillus cereus and Bacillus licheniformis isolated from raw milk, pasteurized milk and yogurt. Bayarri, Carbonell, Barrios, & Costell (2011) also examined the effect of sensory properties of yogurt on the consumer acceptance using clustering analysis. Therefore, in general, in order to properly understand the conditions of industrial production in research, it is necessary to have an analysis of the effect of all production treatments. Therefore, in this study, due to the importance of the production of stained yogurt with the appropriate physicochemical and textural characteristics, in this study, the effect of starter type (probiotic and non-probiotic), milk (58 to 80%), cream (1 to 33%), whey powder (3 to 7%) and milk protein concentrate (6 to 12%) on acidity, pH, viscosity and sensory properties (flavor, color, texture and overall acceptance) of yogurt were evaluated using mixture design and then treatments were clustered and analyzed using two-stage clustering.

Materials and methods

In order to prepare concentrated yoghurt samples, cream, whey powder and milk protein concentrate were added to milk in proportions according to the experimental design. The final dry matter of all samples was constant at 25%. The samples were then homogenized at 50 °C and pasteurized for 30 min at 85 °C and then cooled to 43-45 °C. Commercial and probiotic starter bacteria were added to the prepared formulation (equivalent to 2% of primary milk) according to the manufacturer's instructions and kept at 43-45 °C for 3-4 h. After reaching the desired acidity, they were gently stirred again and then packed in a 200 g plastic container. The produced concentrated yoghurt was transferred to the refrigerator for cooling and storage, and after 24 h, the desired tests were performed on it (Hardi & Slacanac, 2000).

The pH of the samples was measured according to Iranian National Standard No. 2852 (Iranian National Standards Organization [ISIRI], 2006). The viscosity of samples was evaluated at the strain-controlled mode to obtain shear stress versus shear rate data according to the method introduced by Akın, Akın, & Kırmacı (2007). Sensory characteristics of the yogurt including flavor, color, texture, and general acceptance were assessed using a 5-point hedonic test by 10 trained panelists at the room temperature.

Experimental design

In this study, the optimal mixture design was performed by Design Expert software (Version 10.0.1) to observe the effect of starter type (probiotic and non-probiotic), milk (58 to 80%), cream (1 to 33%), whey powder (3 to 7%) and milk protein concentrate (6 to 12%) on acidity, pH, viscosity and sensory properties (flavor, color, texture and overall acceptance) of yogurt. Therefore, the purpose of this methodology was to clarify how the interested properties were affected by the alteration of selected gums in mixture components (Nardi, Acchar, & Hotza, 2004). Then treatments were clustered and analyzed using two-stage clustering.

Results and discussion

The results showed that the linear effects of treatments (milk, cream, whey powder and protein concentrate) on all responses of the samples were significant, so that increasing milk cream led to an increase in pH, viscosity, texture, color and flavor and overall acceptance and decreased acidity of the samples. Increasing whey powder and milk protein concentrate also led to increasing acidity and decreasing pH, viscosity, texture, color and overall acceptance of the samples. The linear effect of the starter type had no significant effect on the responses of the samples. Two-stage data clustering also divided the treatments of this study into two separate clusters and showed that whey powder and milk protein concentrate are not good substitutes for fat. Fig. (1) also shows a diagram of the effect of quantitative and qualitative variables on the clustering of concentrated yoghurt samples.

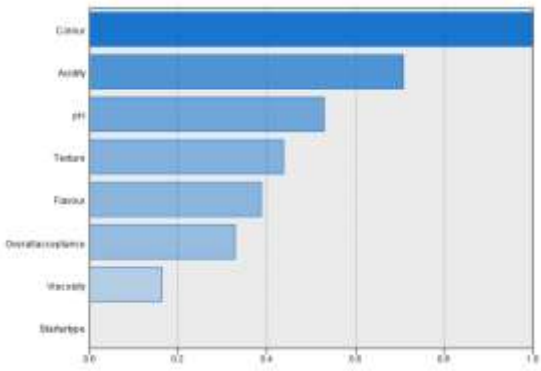

Fig 1. Diagram of the effect of quantitative and qualitative variables on the clustering of concentrated yoghurt samples

According to Fig. (1), color and acidity have played the most important role in the clustering operation. However, the type of starter had no effect on determining clustering. The results of analysis of variance also showed no significance of the starter type on the physicochemical and sensory properties of concentrated yoghurt.

Conclusions

In general, the results of this study showed that milk and cream had same effect on the evaluated properties and led to the improvement of most physicochemical and sensory properties. While milk protein and whey protein concentrate caused further decrease in these properties. The results of two-stage clustering of treatments divided the data of this study into two separate clusters. So that out of 20 treatments, 8 treatments (40%) were in the first cluster and 12 treatments (60%) were in the second cluster. Also, in general, by examining the treatments of each cluster and the average response obtained, it was found that whey powder and milk protein concentrate as fat substitutes could not completely compensate for the loss of fat loss properties ,and therefore it is better to choose better fat substitutes in the concentrated yoghurt formulation.

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