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*Full Length Research Paper*

# The effect of sweeteners and milk type on the rheological properties of reduced calorie salep drink

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**The aim of the study was, to determine effects of sweeteners and milk type on the rheological and sensorial properties of reduced calorie salep drink. In addition to sugar, three different sweeteners; aspartame, saccharine and cyclamate as well as three different milk types; full-fat, low-fat and non-fat; were used for sample preparation. The rheological characterization of samples was described by power-law model. Rheological data revealed that salep samples showed pseudoplastic behavior hence, apparent viscosity decreased with increasing shear rate. The apparent viscosity of sample with sugar and whole milk was 243 mPas at the shear rate of 1 $s^{-1}$, and decreased to 36 mPas at 55 $s^{-1}$ and 27 mPas at 100 $s^{-1}$. While the effect of milk type was significant, that of sweetener type was not significant on apparent viscosity. Statistical results indicated that sweetener type had a significant effect on consistency coefficient. The average consistency coefficient of sample with sugar was 232.64 $mPas^n$, that was 236.89, 261.54 and 249.64 $mPas^n$ for saccharine, cyclamate and aspartame, respectively. As rheological properties are generally considered, there was not statistically significant difference between the results of samples with sugar and saccharine. According to the sensorial analysis, salep prepared with saccharine and low-fat milk was the most preferred low-calorie sample. In conclusion, salep prepared with saccharine and low-fat milk was the most suitable formulation for low-calorie salep preparation.**

**Key words:** Rheology, artifical sweeteners, low-calorie, power-law model, salep drink.

## INTRODUCTION

Salep drink is a traditional dairy beverage which is generally consumed during winter in Turkey. The main ingredients of salep drink are milk, sugar and salep powder which is obtained from tubers of wild orchids. The drink is prepared by boiling sugar and salep powder in the milk and generally served with cinnamon sprinkled on top. Salep drink is generally home made as well as it is sold in small pastry shops in winter. Recently, food manufacturers became interested in the product and instant form which is prepared by addition of hot water or milk and ready to drink form which is just heated up before serving were commercialized. It is believed that salep drink is good for relieving cough and common cold as well as provides the resistance of body towards cold in winter. There are also several studies stating that salep drink is also used for relieving of summer diarrhea of babies and children as well as chronic diarrhea of adults (Tamer et al., 2006).

The salep powder is also main ingredient of Kahramanmaras-type ice cream and not only does it give desired consistency to the product but also enhances the taste and aroma. The most important constituent of natural salep powder is glucomannan which acts as stabilizer and thickener in the product (Tekinşen, 1996). Glucomannan is a dietary fiber hence it helps reducing body cholesterol level by binding bile salts in the intestine. Clinical studies showed that the daily consumption of couple grams of glucomannan reduced total and bad cholesterol

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as well as triglyceride in blood (Tamer et al., 2006; Vuksan et al., 2000; Zhang et al., 1990). The salep powder also contains starch, mineral matter and water in addition to glucomannan.

The rheological properties of fluid foods are very important factors affecting the consumer preference. In addition, it is known that there is a close relationship between rheological and sensorial properties of such kind of foods. For example, boza or hot chocolate with inadequate consistency will generally results in a consumer complaint. Rheological data are important in food processing for several purposes for instance, in the design of process equipments like pumps, pipes and mixers; determination of the ingredient function in a formulation and the control of intermediate and end products (Arslan, 2003; Steffe, 1996). The rheological characterization of fluids is determined by using several models like Power law, Herschel-Bulkley, Casson and Bingham models. Among them, power law is the most often used model for the determination of flow properties of various fluid foods (Köksoy and Kılıc, 2003; Yanes et al., 2002; Genc et al., 2002; Penna et al., 2001; Dogan and Kayacier, 2004; Gabriele et al., 2004; Raina et al., 2006).

Since salep drink is prepared using milk and sugar, it contains considerable amount of calories. A cup of salep drink (200 ml) made from whole milk and sugar contains about 150 Kcal considering the caloric content of ingredients. The number of people with obesity is increasing in the world, and it is a well known fact that obesity is linked to several adverse health effects including cardiovascular diseases, diabetes and stroke. Today more and more people are concerned about their food intake and the penetration of low calorie products in the food market is ever increasing. Food industry is putting a lot of effort to develop alternative low calorie or diet food products containing less fat, sugar and calories to meet the demand in the market. There is no low calorie salep drink present in the food marketplace for the moment and nor is there much study in the literature regarding to it. The objective of this study was to investigate the effect of different sweeteners and milk type on the rheological and sensorial properties of salep drink.

## MATERIALS AND METHOD

Milk (whole, low fat and skim), salep powder and sugar were obtained from local retailer in Kayseri, while the sweeteners (aspartame, saccharine and cyclamate) were kindly provided by Inallar Company (Istanbul, Turkey). For the preparation of samples, 100 ml of milk was heated on the hot plate (Yelowline MST basic, Germany) up to 60°C. Then 0.75 g salep powder and 2.0 g sugar or respective amount of sweetener according to their sweetness compared to sugar (0.011 g of aspartame, 0.005 g of saccharine, 0.065 g of cyclamate) were incorporated into milk and the mixture temperature was raised to 75°C and held for 15 min. The samples then were cooled down to 25°C in the ambient conditions before rheological measurements. Control sample was prepared with whole milk and sugar.

A controlled stress rheometer (Rheostress I, Thermo-Haake, Germany) with a cone-plate configuration was used for rheological measurements of samples. The rheometer was equipped with a water bath (Thermo Haake K15, Germany) to ensure the measurement temperature was constant at 25°C. About 250 μl of sample was placed on the plate of rheometer and sheared in the range of 1 – 100 $s^{-1}$. Total of 30 data points were recorded in the measurement range. Shear stress and apparent viscosity of samples as a function of shear rate were obtained and Rheowin Data Manager Software was used for fitting the data to Power law model to obtain consistency and flow behavior indices of samples.

Sensory evaluation of samples was carried out with a 7 member panel of which were the research assistants or graduate students of Food Engineering department. Panel experienced with sensory evaluation of foods were pre-trained before actual analyses. Panelists ranked the samples by 7-point hedonic scale of which 1 being the worst and 7 being the best for their taste, consistency (mouth feel), and overall preference. The samples were cooled down to 60°C upon preparation before serving to the panelists.

Statistical analysis of samples was carried out by windows based SAS 8.0 software (1988). Analysis of variance was used for determination of the effect of sweetener addition and milk type on the rheological and sensory properties of samples and Duncan test was used for the multiple comparisons.

## RESULTS AND DISCUSSION

The apparent viscosity of all samples decreased with increasing shear rate indicating that salep drink exhibits pseudoplastic behavior. Figure 1 illustrates the change in apparent viscosity of control sample prepared with whole milk and sugar. Similar results were reported by other authors for various dairy products. Dogan and Kayacier (2004) investigated the rheological properties of instant salep and found that the samples showed shear thinning behavior regardless of preparation of samples with milk or water. Similarly Lokumcu et al. (2002) and Koksoy and Kilic (2003) reported that ayran samples viscosity decreesed when shear rate increased. Weak physical, electrostatic and hydrophobic forces within a dairy product affect the rheological properties causing a shear thinning of solution.

The statistical results revealed that the milk type significantly ($p < 0.05$) affected the apparent viscosity of salep. It was found that the AV of samples increased with increasing fat content in the milk at each shear rate within the measurement range of 1 – 100 $s^{-1}$. For example the apparent viscosity sample prepared with full fat milk was 250 mPas at 1 $s^{-1}$ shear rate, however those of low fat and skim milk were 208 mPas and 172 mPas; respecttively. Figure 2 shows the change in apparent viscosity of samples prepared with whole, low and skim milk as a function of shear rate. Similar trend was observed for each sweetener used as well as the control. The reason of changing AV with milk type would be related to dry matter content of samples. Since full fat milk contains more dry matter compared to low and skim milk, the AV of sample with full fat milk was higher than others. Similar conclusion was made by other researchers for ice cream mix, instant salep drink, salep-gum mixed solutions and

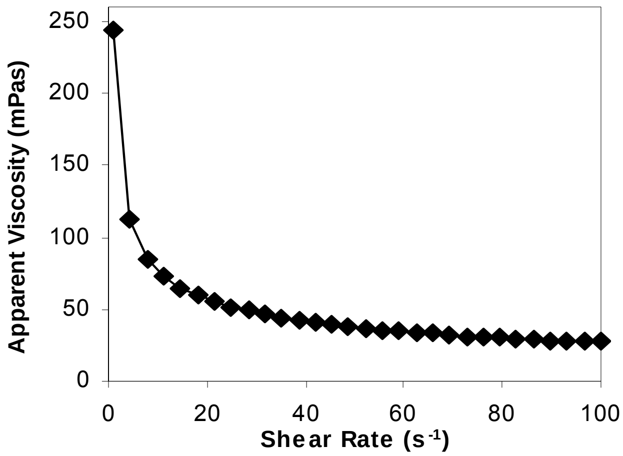


**Figure 1.** The change in apparent viscosity of control sample with respect to shear rate.

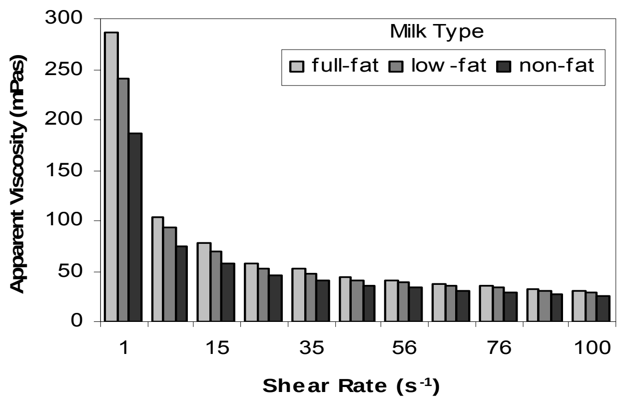


**Figure 2.** The AV of samples prepared with different milk type as a function of shear rate.

pekmez-tahin mix (Kaya and Tekin, 2001; Alpaslan and Hayta, 2002; Kayacier and Dogan, 2006; Maskan and Gogus, 2000).

The addition of sweetener did not significantly ($p>0.05$) affect the AV of samples (Figure 3). It was observed that the AV of control sample was the lowest compared to the samples with sweeteners and the closest value to control sample's AV was obtained for the sample prepared with saccharine.

The shear stress as a function of shear rate data obtained in the study were fit to the Power law model for the determination of consistency coefficient and flow behavior index:

$$\sigma = \mathrm{K}\dot{\gamma}^{(n-1)}$$

where $\sigma$ is shear stress (Pa), K is consistency coefficient ($Pas^n$), $\dot{\gamma}$ is shear rate ($s^{-1}$) and n is dimensionless flow behavior index.

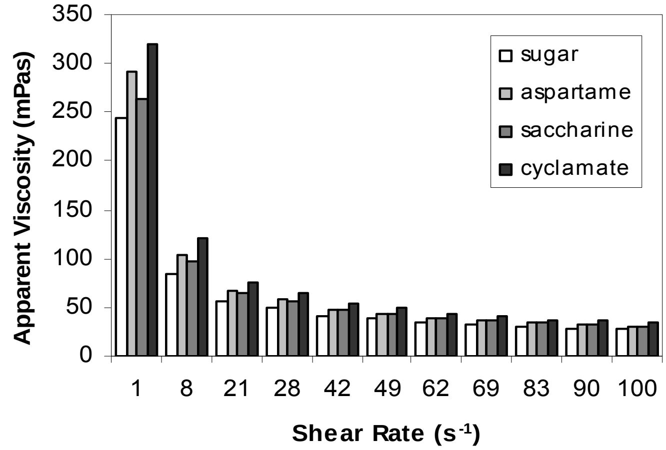


**Figure 3.** The change in AV of samples with different sweeteners.

**Table 1.** The consistency coefficients of samples prepared with different sweeteners and milk types.

| Fat content of milk (%) | K value of Sweeteners ($mPas^n$) | | | |
|---|---|---|---|---|
| | Sugar | Aspartame | Saccharine | Cyclamate |
| 3.4 | $255.32^c$ | $294.08^b$ | $283.57^b$ | $334.20^a$ |
| 1.7 | $253.83^b$ | $243.21^{b,c}$ | $240.53^c$ | $269.12^a$ |
| 0 | $188.77^b$ | $212.78^a$ | $187.59^b$ | $181.29^b$ |

a-c: Different letters correpond significant difference among means within a row

Two-way ANOVA results revealed the addition of sweeteners and milk type significantly ($p < 0.05$) affected the K values of samples. If the milk type was averaged over, the K values of sample with sugar was 196.69 $mPas^n$, it was 226.91 $mPas^n$ for saccharine, 253.10 $mPas^n$ for cyclamate and 255.53 $mPas^n$ for aspartame. In addition for each milk type the effect of sweetener on the K values of samples was also prominent and Table 1 gives the Duncan grouping of K values with different sweeteners for each milk type. Among samples prepared within whole milk, the K value of sugar added sample was significantly lower than those of any other sample with sweetener. On the other hand, for skim milk samples, there was no difference among the results of sugar, saccharine and cyclamate while the K values of sample with aspartame were significantly higher.

The sweetener addition had a significant effect on the n values of salep drink. Table 2 shows the change in n values of salep samples prepared with different sweeteners. According to the Duncan multiple comparison results, there was no difference between n values of sugar and saccharine for all kinds of milk types. The n value of sample prepared using whole milk was 0.526 for sugar and 0.524 for saccharine. Similarly, for non-fat milk used samples, flow behavior index of sugar and saccha-

**Table 2.** The flow behavior index of samples prepared with different sweeteners and milk types.

| Fat content of milk (%) | n value of Sweeteners | | | |
|---|---|---|---|---|
| | Sugar | Aspartame | Saccharine | Cyclamate |
| 3.4 | 0.526[a] | 0.507[b] | 0.524[a] | 0.493[c] |
| 1.7 | 0.539[a,b] | 0.535[b] | 0.543[a] | 0.524[c] |
| 0 | 0.573[a] | 0.545[b] | 0.573[a] | 0.575[a] |

a-c: Different letters correpond significant difference among means within a row.

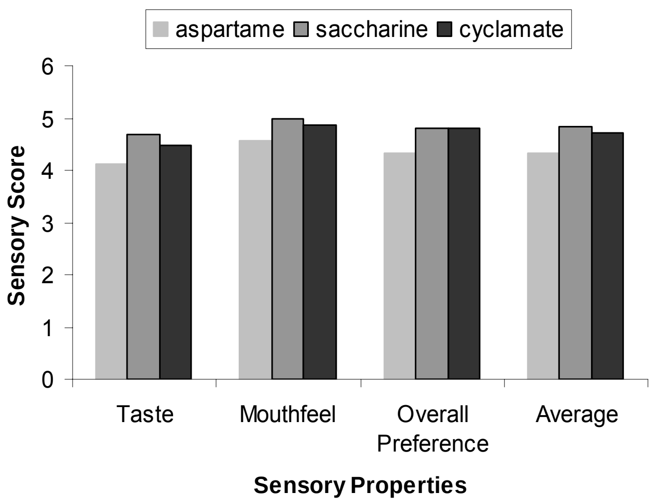


**Figure 4.** Sensory scores of salep samples prepared with different sweeteners.

rine were 0.573.

Figure 4 illustrates the average sensory results of samples in terms of taste, mouthfeel and overall preference. It was found that sample prepared with saccharine received the highest sensory scores among sweetener used salep samples, therefore it could be suggested that saccharine was a proper sweetener for the low calorie salep preparation. It was also determined that the milk type had a significant ($p < 0.05$) effect on the sensory properties of salep beverages. The sensory panel rated the sample with nonfat milk as the worst, however there was no difference between the sensory results of samples with sugar and saccharine.

The caloric value of samples was calculated considering the amounts of sugar and salep used for the preparation of samples as well as the label information of milk. A cup of sample (200 g) with sugar and whole milk had a caloric value of 148.18 Kcal. However the caloric value of the sample with sweetener and nonfat milk was 76.28 Kcal corresponding about 48.72% reduction in caloric value. The reduction of calories in the sample containing low-fat milk and sweetener which had similar sensory properties with whole milk and sugar used sample was around 32.32%.

## CONCLUSION

The rheological studies pointed out that the salep samples regardless of their content showed a shear thinning behavior. Sensory evaluation results revealed that salep sample containing low-milk fat was more preferred than non-fat milk used samples and the difference between the sensory scores of low-fat milk and whole milk samples was not significant. Among sweeteners, saccharine gave the best results not only for sensorial properties but also for rheological properties. As a conclusion it could be stated that low-fat milk and saccharine could be potentially used for the preparation of reduced calorie salep.

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