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Research Article

Physicochemical Characteristics of Powdered Sirkencubin Sherbet: A Comparison of Spray Drying and Freeze-Drying Techniques

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Abstract

In this study, sirkencubin sherbet, a traditional Turkish drink, was powdered using two different drying methods: spray drying and freeze drying. The physicochemical properties of the powders produced by these methods were compared. Sirkencubin sherbet was made from honey, apple cider vinegar, cinnamon, cloves and water, with maltodextrin added as a drying agent. Moisture content, color, pH, titratable acidity, particle density, bulk and tapped density, porosity, flowability, hygroscopicity, wettability, dispersibility and solubility of the powders were analyzed. The results showed that the moisture content of the spray-dried powder (4.92%) was lower than that of the freeze-dried powder (5.68%). Both powders were slightly acidic due to the presence of vinegar. The L* and a* values of the spray-dried powder were higher, while the b* value was lower compared to the freeze-dried powder. The freeze-dried powder exhibited higher hygroscopicity and poorer flow properties than the spray-dried powder. Both powders showed dispersibility and solubility values of over 90 %, indicating good reconstitution properties. The differences in the drying processes resulted in powders with different physical properties, which can affect their handling, storage and processing. This study demonstrates the feasibility of producing sirkencubin sherbet powder by spray drying and freeze drying and provides an alternative form of this traditional beverage for the domestic and international market.

Keywords: Sirkencubin sherbet, traditional Turkish drink; spray drying, freeze-drying, physicochemical properties

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Introduction

Turkish cuisine has evolved over centuries and encompasses a diverse culinary and beverage culture that has been enriched by the incorporation of elements from other cuisines. In particular, Turkiye produces a wide variety of alcoholic and non-alcoholic beverages using different techniques. The origins of beverage culture in the Turkish culinary tradition can be traced back to the fermentation of milk to make yogurt, which was then diluted with water to make ayran (which was occasionally consumed with additives such as salt or mint). As the yogurt proves, there is a long tradition of fermented products in Turkish society [9]. The use of fermentation processes and the consumption of various fermented beverages such as koumiss and kefir during this period show that the consumption of beverages went beyond mere necessity and was not only used to quench thirst or fulfill a physiological need [9]. With the transition to sedentarization, Turkish society became acquainted with different types of cereals, vegetables, fruit, herbs and spices. In addition to the production of boza from cereals, the potential for the production of beverages from fruit was also recognized and efforts were made accordingly. The presence of the term "cülab" (rose water) in the earliest known sources and its use together with the word sherbet indicate the establishment of a sherbet culture and the use of roses in beverages [13]. The emergence of sherbets and syrups, especially in the Seljuk period, is probably due to the need to preserve food. For the purpose of food preservation, fruits were dried and processed into hosaf by adding molasses or honey, which later influenced the development of sherbet [1].

The use of sherbet in its simplest form, a mixture of honey and water, was documented in the 10th century. In the Seljuk period, however, the preparation was expanded by the addition of fruit and spices, which considerably increased its complexity. Later, in the Ottoman Empire, sherbet production reached its peak with the establishment of the halvahane, a specialized department in the palace kitchen [8].

Oxymel, known as sekanjabin in Iran and sirkencubin in Türkiye, is a Seljuk sherbet drink with a high carbohydrate content, containing apple cider vinegar, honey and possibly cinnamon and cloves. The term sirkencubin is composed of the Farsi words serke (vinegar) and angabin (honey) [18, 21]. In a medical text by Ibn-i Şerif from the 15th century, the recipe for sirkencübin is described as follows: About 617 grams of honey are boiled with 617 grams of water, 77 grams of vinegar are gradually added and boiled until the water evaporates and the mixture thickens. This concentrated solution is then dissolved in four spoons of water for consumption [18]. Sirkencubin sherbet is a drink specific to Mevlevi cuisine. The Ottoman sultans mainly consumed it during Ramadan. Sirkencubin sherbet is said to alleviate indigestion, induce satiety and promote weight loss when consumed on an empty stomach. It is also said to have a number of health benefits. Consuming a glass of Sirkencubin sherbet after a meal is said to aid digestion, while consuming it before a meal creates a feeling of satiety and reduces overeating [19].

It is important to keep Turkish culture alive by offering traditional Turkish sherbet varieties to the national and international market in the most practical way. Nowadays, many beverages and liquid products are converted into powder form for easy storage. This preservation method is practical for transportation as well as for use in various recipes. In this study, it was aimed to produce a powder product by drying Sirkencubin sherbet, a traditional Turkish sherbet that is not widely available in liquid form, using two different drying methods (freeze-drying and spray-drying). The physicochemical properties (moisture content, color, pH, titratable acidity, particle density, bulk and tapped density, porosity, flowability, hygroscopicity, wettability, dispersibility and solubility) of the powder produced by two different drying methods were compared.

Materials and Methods

Materials

Honey, vinegar, cinnamon and cloves used in this study were purchased from a local market in Gaziantep. All solvents and chemicals used were purchased from Sigma Aldrich (St. Louis, MO, USA).

Production of Sirkencubin Sherbet

A comprehensive literature search was carried out and various recipes were examined in order to develop an original recipe based on several sirekencubin recipes. To

prepare 1 L of syrcubin syrup, 1 cinnamon bark and 4 cloves were steeped in 600 mL of purified water at 85°C for 1-2 hours. The mixture was then filtered and 300 mL of water was added. Then 30 mL of apple cider vinegar and 100 g of honey were added and homogenized using a whisk until the honey was completely dissolved. Maltodextrin was added to the sherbet at a concentration of 10 % (w/w) as a drying agent and homogenized using a homogenizer (Daihan Scientific, HG-15A, Korea) at 1000 rpm for 10 minutes.

Spray Drying

Experiments were carried out in a laboratory-scale spray dryer (Büchi Labortechnik AG, Flawil, Switzerland). Sherbet was atomized from the nozzle into a vertical co-current drying chamber. The drying conditions were set to an air inlet temperature of 185°C, an air outlet temperature of 75°C, an aspiration speed of 100 and a hot air flow rate (5 m^3/min). The conditions for the spray drying process were determined taking into account the study conducted by Koç [15], which was found to be the optimum condition for honey powder. The dried powder was collected in a single cyclone separator and then packed in jars and stored in the dark until used for analysis.

Freeze Drying

Freezedrying of sherbet was performed at −55 °C for 48 hours using a freeze dryer (FreeZone 6, Labconco, USA). After drying, the samples were grinded, packaged and stored in the dark until used for analysis.

Analysis

Moisture contents of powders were determined by infrared moisture analyzer at 105˚C. A colorimeter (3NH colorimeter, China) was used for color measurements of (CIE L^*, a^* and b^* values). The acidity was measured by potentiometric titration with a standard alkali up to the inflection point of the titration curve (pH 8.1). The results were expressed as a percentage of anhydrous citric acid, while the pH measurement was performed with a pH meter.The bulk density (ρ_b) and tapped density (ρ_t) and porosity (ε) of samples were determined using the method reported by Jinapong et al. [12]. In addition, the particle density (ρ_p) of the powders was analyzed by a pycnometric technique with 2-propanol as previously reported by Barbosa-Cánovas et al. [4]. The flow characteristics of the powder samples were described as Carr index (CI) and Hausner ratio (HR) using equations (1) and (2), respectively [6, 7]. The wettability and dispersibility of the powders were determined as reported by Jinapong et al. [12]. The solubility of the powders was performed as specified by Cano-Chauca et al. [5]. Solubility (%) was calculated using the mass difference (after drying/initial weight). Hygroscopicity was evaluated according to Al-Kahtani and Hassan [2]. The avocado powder (1 g) was evenly distributed on petri dishes (5 cm in diameter) at 25 °C a saturated NaCl solution, ensuring a relative humidity of 75.3%. Samples were weighed after 90 minutes. Hygroscopicity was reported as g moisture/g dry solids.

$$CI = \frac{(\rho_t - \rho_b)}{\rho_t} \times 100 \quad (1)$$

$$HR = \frac{\rho_t}{\rho_b} \quad (2)$$

The presented results are an average of triplicate observations. The statistical analysis was carried out using SPSS Statics 24.0 (SPSS Inc., Chicago, USA). One-way ANOVA was conducted to define the effect of drying methods on quality parameters of sherbet powder. Duncan multiple range test was used at 95 % significance level to see the significant differences.

Results and Discussion

In this study, two different drying techniques were used to obtain powdered products from Sirkencubin sherbet in order to evaluate alternative uses for the sherbet. The physical and chemical properties (moisture content, pH, titratable acidity, L^*, a^*, b^*, bulk density, tapped density, porosity, particle density, dispersibility, wettability, solubility, and hygroscopicity) of the powder products obtained by two different drying processes are shown in Table 1. Figure 1 shows images of sirkencubin sherbet powders produced by spray drying and freeze drying. The hygroscopicity values are given in Figure 2.

The moisture content of the spray-dried sirkencubin sherbet powder sample was 4.92%, while the moisture content of the freeze-dried sirkencubin sherbet powder sample was

5.68%. The moisture content values of sherbet powders produced by both methods are below 10%, which indicates that the powders are microbiologically and oxidatively safe and can be stored for a long time [16]. High moisture content in powder products is important in processing, storage and packaging processes and affects properties such as flowability and stickiness of the powder product [14]. In addition, a statistically significant difference was found in the moisture content of the sirkencubin sherbet powder produced by these two methods ($p < 0.05$). Yaşar [20] reported that the moisture content of spray-dried pomegranate juice is between 2.4% and 4.0% and found that the optimum yield of powder products was achieved with a 50/50 ratio of concentrated pomegranate juice to maltodextrin. Increasing the maltodextrin content in the spray-dried sirkencubin sherbet powder can further reduce the moisture content and increase the powder yield.

The acidity of sirkencubin sherbet powders produced by two different drying methods was determined to be below pH 7. The powders are slightly acidic, as vinegar is the main component of the sherbet. Maltodextrin increased the glass transition temperature of the sherbet, and the drying processes were successfully carried out despite the presence of acetic acid and sugar in the sirkencubin sherbet. Statistical analysis revealed that a significant difference ($p < 0.05$) in the pH values of the sirkencubin sherbet powder produced using two different methods, whereas no significant difference ($p > 0.05$) was found in titratable acidity.

As one of the first quality attributes perceived by consumers, color should be considered as a crucial parameter influencing the assessment of taste and overall product quality [7]. Among the various quality-determining attributes, color proves to be the most critical factor that consumers immediately perceive when evaluating a product. This visual aspect has a significant impact on the individual perception of the taste and overall quality of the product [7]. The L^* and a^* values of the sirkencubin sherbet powder produced by the spray-drying method were higher and the b^* value was lower than that of the freeze-dried sherbet powder. Although this is a statistically significant difference, it is not noticeable in terms of the appearance of the powder products. The images of the powder products are shown in Figure 1. Unlike the results of this study, Barbosa et al. [3] reported the L^* value of probiotic orange juice powder as 64.44 as a result of spray drying and 72.11 in freeze-dried sample. In the production of honey powder by spray drying and freeze drying, L^* values were determined as 84.40 and 90.47, respectively [15]. L^* values of spray-dried and freeze-dried powder products vary due to the sugar, fat, acid content of the product; drying temperature, browning reaction that may occur in spray drying. A review of studies in the literature revealed that the L^* values of powdered products derived from colorless beverages with maltodextrin-enriched honey were generally above 90. The similarity in color values between the spray-dried powdered product and the freeze-dried powdered product suggests that the product was not burning. It is also assumed that the increased L^* value is due to the maltodextrin contained as a drying agent.

It is assumed that the increased moisture content and hygroscopicity of the sample obtained by freeze-drying are due to the fine powder and the increased stickiness during spray-drying. As shown in Figure 1, sirkencubin sherbet powder exhibits higher caking. Goula and Adamopoulos [10] reported that the hygroscopicity values of orange juice powder obtained by spray drying were between 4.2 and 5.3 %. The percentage of hygroscopicity of spray-dried sirkencubin sherbet was determined to be 4.72% after 90 minutes, giving comparable results. For freeze-dried sirkencubin sherbet powder, these values were determined to be 5.52 %, which indicates a higher hygroscopicity. Although the porosity of freeze-dried products is generally higher due to sublimation, the porosity value of the powder product obtained by spray drying in this study is higher. This phenomenon is due to the sugar and acid content of the product and the effect of stickiness during spray drying.

Although the bulk and tapped densities of freeze-dried powders are generally lower than those of other drying processes. As mentioned above, the bulk and tapped density values of the freeze-dried sherbet powder in this study are higher. Increased bulk density values facilitate packaging and transportation, while reducing flow properties. The ratio of compressed density to bulk density, known as the Carr index and Hausner ratio, are commonly used methods. The Carr index serves as an indicator of flowability, while the Hausner ratio

indicates stickiness. A Hausner ratio of less than 1.25 is interpreted as an indicator of free flow, while a higher value indicates poor flow properties. In this study, the freeze-dried powder product was found to have poor flow properties, while the spray-dried powder product was free-flowing. The reason for the better flowability is the lower difference between bulk and tapped density. The results of the statistical analysis show that there is a clear difference ($p < 0.05$) in several properties of the sirkencubin sherbet powder produced by two different methods. These properties included bulk and tapped density, Carr index, Hausner ratio, and porosity values. However, there is no substantial difference ($p > 0.05$) in particle density between the two production methods. The differences between the two drying processes result in powders with different physical properties, which can affect their handling, storage and processing. Freeze-drying produces a more compact, less porous and more compressible powder. Spray drying, on the other hand, produces a powder that is more porous and flows more easily.

Wettability refers to the time it takes for a dry powder to completely wet into a liquid when added to water or another solution. The wettability of the product decreases with increasing wetting time. Freeze-dried sirkencubin sherbet powder has poorer wettability than spray-dried powder. In particular, both sirkencubin sherbet powders have a dispersibility and solubility of over 90 %, which increases the versatility of the product. The particle density of the samples is very similar and significantly higher than the density of water, which contributes to better reconstitution properties. Mutlu [17] reported an average solubility of 95.02% for spray-dried honey powder, which varies depending on the type of carrier used. When combined with pure water, the solubility of honey powder was 93.67%, while it decreased slightly to 92.73% when combined with orange juice instead of water. These results are consistent with the observation of the current study that vinegar influences solubility.

In the analysis performed, the degree of caking was investigated; however, the powders crystallized while the product was in the oven during the analysis method, so it was not possible to measure the degree of caking.

Conclusion

This study compared the physicochemical properties of sirkencubin sherbet, a traditional Turkish drink, powdered using spray-drying and freeze-drying. The spray-dried powder had a lower moisture content (4.92%) than the freeze-dried powder (5.68%). Both powders were slightly acidic due to the presence of vinegar. The spray-dried powder had higher L^* and a^* values and a lower b^* value than the freeze-dried powder. The freeze-dried powder had higher hygroscopicity and poorer flow properties than the spray-dried powder. Both powders showed good reconstitution properties with dispersion and solubility values of over 90%. The differences in the drying processes resulted in powders with different physical properties, which can affect their handling, storage and processing.

References

1. Akın, G., Özkoçak, V., & Gültekin, T. (2015). Geçmişten günümüze geleneksel Anadolu mutfak kültürünün gelişimi. Antropoloji, (30), 33-52.
2. Al-Kahtani, H.A., Hassan, B.H. (1990). Spray drying of roselle (Hibiscus sabdariffa L.) extract. Journal of Food Science, 55(4), 1073-1076.
3. Barbosa, J., Borges, S., Amorim, M., Pereira, M. J., Oliveira, A., Pintado, M. E., Teixeira, P. (2015). Comparison of spray drying, freeze drying and convective hot air drying for the production of a probiotic orange powder. Journal of Functional Foods, 17, 340-351.
4. Barbosa-Cánovas, G. V., Ortega-Rivas, E., Juliano, P., Yan, H., Food powders: physical properties, processing, and functionality. (Kluwer Academic/Plenum Publishers, New York, 2005)

5. Cano-Chauca, M., Stringheta, P. C., Ramos, A. M., & Cal-Vidal, J. (2005). Effect of the carriers on the microstructure of mango powder obtained by spray drying and its functional characterization. Innovative Food Science & Emerging Technologies, 6(4), 420-428
6. Carr, R.L., 1965, Evaluating flow properties of solids, Chemical Engineering, 72:163-168 pp.
7. Chen, H. H., Hernandez, C. E., & Huang, T. C. (2005). A study of the drying effect on lemon slices using a closed-type solar dryer. *Solar Energy*, *78*(1), 97-103.
8. Çelik, S (2020. 19. Ve 20. Yüzyılın Türk kültür hayatında şerbet Anadolu Üniversitesi (Sosyal Bilimler Enstitüsü / Tarih Ana Bilim Dalı).
9. Dilmeç, H., & Koç, B. (2023). Turkish Culinary Culture from The Past to The Present. *Food Health and Technology Innovations*, *6*(13), 540-548.
10. Goula, A. M., & Adamopoulos, K. G. (2010). A new technique for spray drying orange juice concentrate. *Innovative Food Science & Emerging Technologies*, *11*(2), 342-351.
11. Hausner, H. H. (1967). Friction conditions in a mass of metal powder. Polytechnic Inst. of Brooklyn. Univ. of California, Los Angeles.
12. Jinapong N., Suphantharika M. And Jamnong P., 2008, Production of instant soymilk powders by ultrafiltration, spray drying and fluidized bed agglomeration, Journal of Food Engineering, 84:194-205 pp.
13. Kobya, E. Ş. (2013). KUTADGU BİLİG'DE YİYECEK VE İÇECEK ADLARI. *Electronic Turkish Studies*, *8*(8).
14. Koç, B., Koç, M., & Baysan, U. (2021). Food Powders Bulk Properties. In E. Ermiş (Ed), Food *Powders Properties and Characterization* (pp. 1-36). Springer, Cham.
15. Koç, M. (2015). Drying Condition Methods p:121-124, In Doctoral Dissertation. " Optimization of the Honey Powder Production Conditions with Different Drying Methods and Determining the Storage Stability" 202 pages. Ege University, Graduate School of Natural and Applied Sciences, İzmir.
16. Koç, M., Koç, B., & Kaymak-Ertekin, F. (2011). Toz gıdaların fiziksel karakterizasyon özellikleri. Akademik Gıda, B (4), 60-70
17. Mutlu, C. (2016). Balın biyoaktif bileşenlerinin korunarak kurutulması ve üretilen bal tozlarından soğuk içecek karışımı hazırlama imkanlarının araştırılması.
18. Orhan, H. İ. (2020). Mevlana ve Antik Şerbet Sirkencübin (Oxymel) Arasındaki İlişkinin Gastronomi ve Sağlık Perspektifinden İncelenmesi. İstanbul Ayvansaray Üniversitesi SBE, Yüksek Lisans Tezi, İstanbul.
19. Sarıoğlan, M. & Cevizkaya, G. (2016). Türk Mutfak Kültürü: Şerbetler. Ordu Üniversitesi Sosyal Bilimler Enstitüsü Sosyal Bilimler Araştırmaları Dergisi, 6 (14) , 237-250.
20. Yaşar, M. (2008). Nar suyuna farklı oranlarda maltodekstrin eklenerek püskürtmeli kurutucu ile nar suyu tozu elde edilmesi üzerine bir çalışma/A study on production of pomegranate juice powder via spray drier by adding different quantities of maltodextrin to pomegranate juice (Doctoral dissertation).
21. Yenişehirlioğlu, E., & Kalaycı, İ. (2021). Tandır Çorbası, Ispanaklı Bulgurlu Borani, Sirkencubin ve Badem Helvasının Akdeniz Diyeti Kapsamında İncelenmesi.

Table 1. Physicochemical Properties of Powder Sherbet

Properties/Sample	FD	SD
Moisture Content	5.677 ± 0.139[a]	4.917 ± 0.304[b]
Titratable acidity	0.178 ± 0.000[a]	0.161 ± 0.016[a]
pH	5.150± 0.380[b]	6.185 ± 0.233[a]
L^*	95.25 ± 1.067[b]	97.74 ± 0.649[a]
a^*	0.304± 0.155[b]	0.592± 0.115[a]
b^*	5.892 ± 0.215[a]	4.912 ± 0.765[b]
Bulk density (kg/m^3)	489.0 ± 16.99[a]	343.6 ± 11.99[b]
Tapped density (kg/m^3)	646.3 ± 47.42[a]	420.3± 12.89[b]
Particle density (kg/m^3)	1427 ± 65.32[a]	1425 ± 29.57[a]
Carr Indeks	24.33 ±4.187[a]	18.24 ±2.214[b]
Hausner Ratio	1.322 ± 0.071[a]	1.223 ± 0.033[b]
Porosity	54.71 ± 3.323[b]	70.50 ± 0.905[a]
Wettability (s)	8.315 ± 0.445[a]	1.000 ± 0.000[b]
Dispersability (%)	93.101 ± 0.655[b]	99.701 ± 0.205[a]
Solubility (%)	87.76 ± 0.572[b]	90.84 ± 0.456[a]

[*] FD freeze dried sirkencubin sherbet, SD spray dried sirkencubin sherbet. [ab]Means within a row with different letters are significantly different ($p < 0.05$)

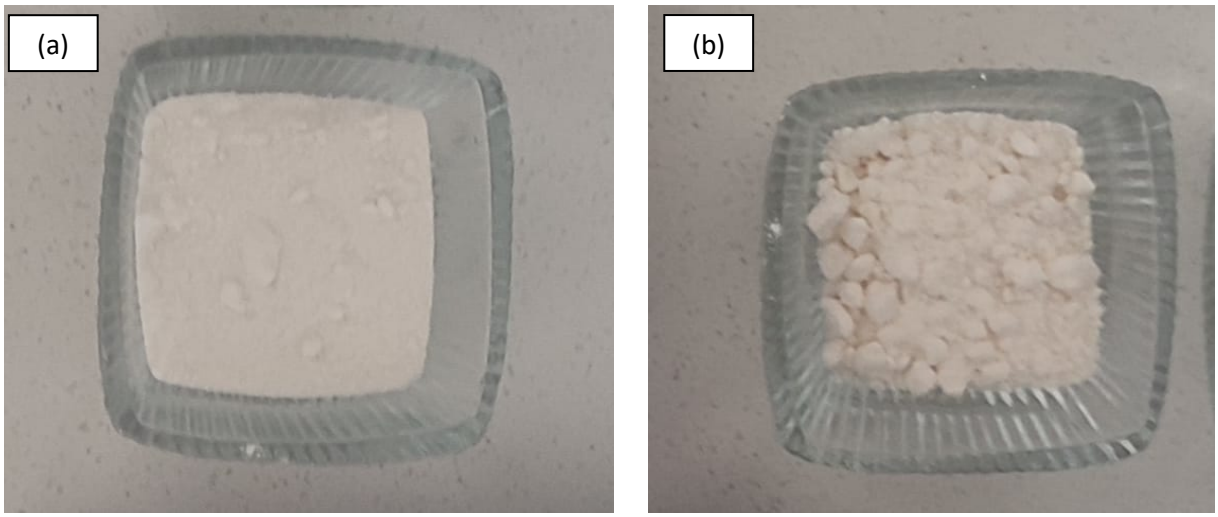

Figure 1. Images Of Sirkencubin Sherbet Powder. (A) Freeze Dried, (B) Spray Dried.

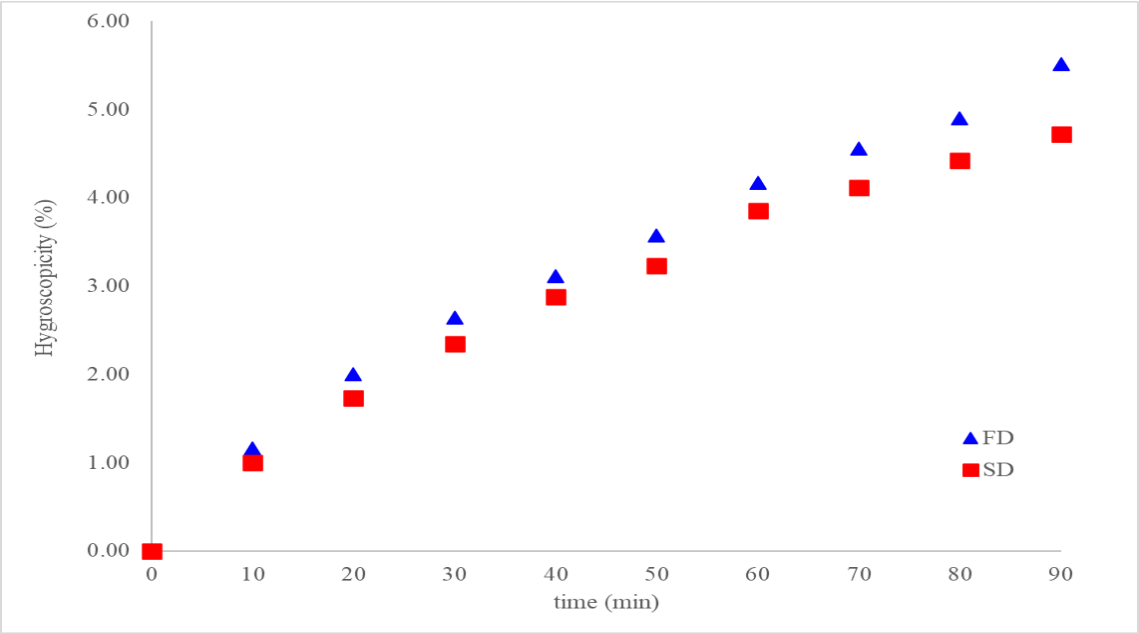

Figure 2. Hygroscopicity Of Sirkencubin Sherbet Powders At 25 °C And 75.3% RH