

Possibilities for the use of whey in tel kadayıf (a Turkish dessert) production

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Abstract: The utilisation of whey is very important for preventing the waste of a protein- and lactose-rich dairy by product and protecting the environment. Therefore, the objective of this study was to investigate the effect of whey use in tel (wire) kadayıf (a Turkish dessert raw material) production on microbiological and technological properties and sensory characteristics of tel kadayıf. For this purpose, 3 experimental tel kadayıf samples were produced using different amounts (0%, 25%, and 50%) of fresh whey instead of water in the production of raw tel kadayıf. The samples were placed in plastic bags and vacuum packaging and stored in a refrigerator (4 °C). Storage period (1, 3, 5, and 7 days) analysis was performed. The results of the research showed that nutritional value and sweetness increased, while the baking time decreased with respect to increases in the amount of whey used in tel kadayıf. As a result of a collective evaluation of the study findings, it was concluded that a 25% whey addition and vacuum packaging would provide the most positive quality characteristics in tel kadayıf desserts.

Key words: Turkish dessert, whey, tel kadayıf, food properties, sensory analysis, package

1. Introduction

Kadayıf is a common Turkish dessert. There are different types of kadayıf: tel (wire) and bread kadayıf, both of which can be prepared with either walnuts or pistachios. Consumed as a dessert in the Balkans, Turkey, and Middle Eastern countries, kadayıf was the most delicious variety of eighteenth-century Turkish food (Işın, 2013). Tel kadayıf is the main ingredient of sweet pastries or desserts that are common in Turkey. It has a texture similar to that of shredded wheat and is made from very soft dough prepared with flour and water. According to the Standard of Tel Kadayıf (TS 10344, 1992), it is a semi-processed product made by pouring dough on a plate to bake and is prepared by adding drinking water to sieved wheat flour. The dough is dried by sending it through very tiny holes and onto a turning hot plate, and the threads are then collected into skeins (Büyük Larousse, 1986). This semi-processed product can be stored for 3 to 5 days in a refrigerator. Different types of desserts made from tel kadayıf are served in almost all restaurants in Turkey, and the history of these desserts goes back hundreds of years (Çakmakçı and Aydın, 2001). Compared to the 0% whey control group, the fragility of samples increased with the addition of whey, and they became drier according to the whey level. It was also observed that the addition of whey produced a sweeter, pleasant taste in tel kadayıf samples

that was similar to that of fresh cheese. On the basis of these observations, it was concluded that tel kadayıf produced with a whey addition of more than 25% would be proper for the preparation of tel kadayıf dessert, with sugar syrup (Çakmakçı and Aydın, 2001).

There is no official record regarding annual kadayıf production and consumption in Turkey. Tel kadayıf, which is mostly produced by small manufacturers, is also factory-made in large quantities. Information about tel kadayıf is not common in the literature, and not enough interest is given to this special product; therefore, there is no comprehensive tel kadayıf study.

Whey is a nutritious by-product of cheese. Approximately 150 million tons of whey is available around the world (Smithers, 2008). It contains approximately half of the total milk solids, 70% of the lactose, 20% of the milk proteins, 70%–90% of the milk minerals, and almost all the water soluble vitamins originally present in milk (Horton, 1995; Ismail et al., 2011). Therefore, evaluation of whey is very important. Whey represents a rich source of protein and has often been overlooked as a source of physiologically functional protein. Whey protein and whey protein fractions are important ingredients in health-promoting foods (McIntosh et al., 1998). Whey powder is used in the food industry as an additive in many processed foods such as breads, crackers, and commercial pastries. Whey is

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widely used in preparing healthy, dietetic, and nutritious foods for infant development, especially owing to the different functional qualities of whey proteins (Ertugay et al., 1987; Koçak and Aydemir, 1994; de Wit, 1998; Ju and Kilara, 1998; McIntosh et al., 1998; Tossavainen et al., 1998; Aydın, 2000; Çakmakçı and Şengül, 2002).

Liquid whey could be used in place of water without any further processing or expense for the production of certain foods. Tel kadayıf could be among those foods in which kneading water in the formulation could be replaced with liquid whey. As a result of whey use, the nutritional value of kadayıf could be improved. Since whey is rich in lactose, the sweetness of tel kadayıf could be improved, and the need for syrup (sucrose) to make tel kadayıf dessert could be reduced (Çakmakçı and Aydın, 2001). The objective of the current study was to investigate the effect of whey use in tel kadayıf production on some microbiological and technological properties and sensory characteristics of tel kadayıf desserts. In addition, Çakmakçı and Aydın's (2001) recommendations on the optimum shelf life of raw tel kadayıf samples stored in vacuum packages or plastic bags between 1 and 7 days were investigated.

2. Materials and methods

2.1. Materials

Flour (type 650) used in the production of tel kadayıf was purchased from a local market (Erzurum, Turkey). Fresh whey was acquired homogeneously from the whole mass obtained through filtration of cheese curd during white (beyaz) pickled cheese production in a pilot dairy plant of the Faculty of Agriculture, Atatürk University (Erzurum, Turkey). Table 1 presents the analysis results of flour and whey used in the production of tel kadayıf.

2.2. Methods

2.2.1. Production of tel kadayıf

Experimental tel kadayıf samples were produced according to the procedure outlined by a local manufacturer (Keleş

Kadayıf Factory, Erzurum, Turkey). First, 12 kg of sifted wheat flour was divided into 3 parts (4 kg each). Tel kadayıf samples were produced using 3 different amounts of whey (0%, control: 6 L of water; 25%: 1.5 L of whey and 4.5 L of water; and 50%: 3 L of whey and 3 L of water) supplemented with 50%, 25%, and 0% ordinary water, respectively. Almost 500 g of tel kadayıf was placed into polythene bags [high-density polyethylene (HDPE nylon)] and packaged with a vacuum packaging machine (Ünal KVG-010; Adapazarı, Turkey) in vacuum bags (polyethylene/polyamide; O₂ transmission rate 70.2 mL/m²/24 h/23 °C) and then stored in a refrigerator (4 ± 1 °C) until analysis. The samples were analysed after 1, 3, 5, and 7 days of refrigerated storage.

2.2.2. Analysis methods

Water and protein (AACC, 1983), ash (ICC Standards, 1967), and fat contents (Elgün et al., 1999) of the flour were determined according to the literature, and the Zeleny sedimentation value was obtained by the procedure suggested by Elgün et al. (1999). Dry matter, ash, fat, and protein contents and titratable acidity (lactic acid %) of the whey were analysed using standard procedures (Kurt et al., 1996). The specific weight of whey was determined according to the method of Kurt et al. (1996) using a lactodensimeter. For the samples of unbaked tel kadayıf, fat, protein, and dry matter content were determined by the method of Elgün et al. (1999). Colour measurements of tel kadayıf baked after 7-day storage were made by a Minolta Colorimeter-CR-200 (Minolta Camera Co., Osaka, Japan) according to the method proposed by Certel (1990). Each sample was put into a flat glass dish for measurements. The results were expressed as Hunter *L* (whiteness/darkness), *a* (red/green), and *b* (yellow/blue) values. The sensory properties of the baked and sweetened tel kadayıf desserts were evaluated after 1, 3, 5, and 7 days of storage by 8 trained panellists who were familiar with tel kadayıf dessert. Approximately 5 g of unbaked kadayıf sample was weighed and placed on stainless steel metal plates and then baked without oil in a kitchen oven at 200 °C for 6 min. Just after the measurement of colour density, an equal amount of cold sherbet (a liquid that is boiled for 8 min after the addition of 35% sucrose + 65% water and boiled again for 2 min with the addition of 1% lemon juice) was added to each sample. Prepared samples were held at ambient conditions for 2 h before serving to the panellists for sensory evaluation. Each panel member assessed the samples for sensory attributes including colour, texture, flavour, sweetness, and general acceptability. All sensory attributes were recorded on a 1 (poor) to 9 (excellent) point scale. Water was also provided to the panel members to cleanse their palates between samples.

Table 1. Analysis results of the flour and whey used in the production of tel kadayıf.

Measured parameter	Flour	Whey
Moisture (%)	13.72	-
Dry matter (%)	-	6.19
Protein (%)	11.06	0.78
Ash (%)	0.637	0.49
Fat (%)	1.41	0.50
Zeleny sedimentation (%)	19.12	-
pH	-	6.34
Specific weight	-	1.022

2.2.3. Statistical analysis

The experiments were carried out in duplicate, and the analysis was performed in triplicate. The research was carried out according to factorial design, with 3 different processes: 0% control, 25%, and 50% whey-added tel kadayıf dough water; different packaging types (plastic bags and vacuum packages); and 4 storage durations (1, 3, 5, and 7 days) using 2 replicates. The results were analysed using variance analysis by the Statistica statistical package, and differences among means were compared using Duncan's multiple comparison test.

3. Results

Compared to the whey control (0%) group, the fragility of samples increased with the addition of whey, and they became drier according to the whey level. It was also observed that the addition of whey produced a sweeter taste in the fresh tel kadayıf samples, and they had a flavour similar to that of fresh cheese. On the basis of these observations, it was concluded that tel kadayıf produced with the whey addition of 25% or 50% would be proper for the preparation of tel kadayıf dessert with the addition of sugar syrup. In comparison with the control sample, increases in the dry matter content of tel kadayıf were 2.84% and 9.81% for 25% and 50% whey-added samples, respectively. The increases in milk fat content of tel kadayıf were 20% and 35% for 25% and 50% whey-added samples, respectively. The increases in protein content were 15.82% and 27.55% for 25% and 50% whey-added samples, respectively (Table 2). Therefore, nutritional values of tel kadayıf increased with added whey.

The microbiological characteristics of raw tel kadayıf samples stored in vacuum packages or plastic bags were studied during 7 days of storage (Table 3). Coliform bacteria, yeast, and moulds were not found in any of the raw tel kadayıf samples. Total aerobic mesophilic bacteria (TAMB) counts of all tel kadayıf samples decreased during the storage period (Table 3). Analysis of the flour and whey used in the production of tel kadayıf, nutritional values of non-baked tel kadayıf, microbiological counts of fresh and stored tel kadayıf in different packages at different whey addition levels prior to baking, colour values after baking,

and sensorial analysis results from the tel kadayıf dessert samples are shown in Tables 2–5, respectively.

4. Discussion

When whey is used in the production of tel kadayıf dry matter, fat, and protein ratios increase in the finished product (Table 2). This shows that the addition of whey increases the nutritional value of tel kadayıf desserts. Similar results have been indicated in the literature (Ertugay et al., 1987; Koçak and Aydemir, 1994; de Wit, 1998; Tossavainen et al., 1998; Aydın, 2000; Çakmakçı and Aydın, 2001; Çakmakçı and Şengül, 2002). During the baking process, it was determined that tel kadayıf with added whey baked more quickly than the control samples; therefore, it could contribute to savings in energy and time. For example, at 200 °C for sufficient frying at 50%, 25%, and 0% (control) supplementation with whey, raw kadayıf required 5, 6, and 12 min, respectively. Therefore, approximately 50% savings in electrical energy were achieved (Figure 1). As the amount of whey increased, the amount of dry matter in tel kadayıf also increased. According to the Turkish Standard for Tel Kadayıf (TS 10344, 1992), the moisture content of unbaked tel kadayıf should be a maximum of 35%, and all samples were found to comply with the standard in terms of dry substance.

Coliform bacteria, yeast, and moulds were not found in any of the raw tel kadayıf samples. In this regard, raw kadayıf samples at 7 days are microbiologically reliable. TAMB counts of all tel kadayıf samples decreased during the storage period. The TAMB counts of raw kadayıf samples in plastic bags and those in vacuum packaging were significantly different, and vacuum packed sample TAMB counts were lower (Table 3).

In the colour measurements made by colorimeter, red and yellow colour intensity in baked kadayıf increased with whey addition, and 50% whey addition produced the highest red colour value, followed by the 25% whey-added sample (Table 4). Similar results were found in bread by Ertugay et al. (1987). No significant difference in *a* or *b* values was found among any samples during storage. However, a significant difference was found between package type, and in vacuum packaged samples the *a*

Table 2. The effects of different whey levels on dry matter, fat, and protein content of non-baked tel kadayıf samples.*

Whey levels (%)	Dry matter		Fat		Protein	
	%	Increase (%)	%	Increase (%)	%	Increase (%)
Control (0)	76.14b	-	0.40c	-	9.80c	-
25	78.30ab	2.84b	0.48b	20b	11.35b	15.82b
50	83.55a	9.81a	0.54a	35a	12.50a	27.55a

*Numbers with the same letters in a column are not statistically different at $P > 0.05$.

Table 3. The effects of different whey levels, packaging type, and storage period on some microbial counts of non-baked tel kadayıf samples.*

Whey level (%)	Package type	Storage period (day)	TAMB ¹ (log cfu/g)	Coliform bacteria (log cfu/g)	Yeast and mould (log cfu/g)
0 (control)	Plastic bag	1	6.36 a	<1	<2
		3	6.37 a	<1	<2
		5	5.14 cd	<1	<2
		7	4.55 ef	<1	<2
		Average	5.61 a	<1	<2
	Vacuum	1	6.31 a	<1	<2
		3	5.40 bc	<1	<2
		5	4.39 f	<1	<2
		7	4.36 f	<1	<2
		Average	5.12 c	<1	<2
25	Plastic bag	1	6.19 a	<1	<2
		3	5.69 b	<1	<2
		5	4.90 de	<1	<2
		7	4.45 f	<1	<2
		Average	5.31 b	<1	<2
	Vacuum	1	6.13 a	<1	<2
		3	5.33 bc	<1	<2
		5	4.85 de	<1	<2
		7	4.23 f	<1	<2
		Average	5.13 bc	<1	<2
50	Plastic bag	1	5.21 cd	<1	<2
		3	5.43 bc	<1	<2
		5	4.85 de	<1	<2
		7	4.25 f	<1	<2
		Average	4.94 d	<1	<2
	Vacuum	1	5.16 cd	<1	<2
		3	5.25 cd	<1	<2
		5	4.55 ef	<1	<2
		7	4.26 f	<1	<2
		Average	4.80 d	<1	<2
Storage period average		1	5.89 a	<1	<2
		3	5.58 b	<1	<2
		5	4.78 c	<1	<2
		7	4.35 d	<1	<2
Whey addition average		0	5.36 a	<1	<2
		25	5.22 b	<1	<2
		50	4.87 c	<1	<2
Package type		Plastic bag	5.28 a	<1	<2
		Vacuum	5.02 b	<1	<2

*Numbers with the same letters in a column are not significantly different at $P > 0.05$.

¹TAMB: total aerobic mesophilic bacteria.

Table 4. The colour values in fresh and stored tel kadayıf samples produced at different whey addition levels after baking.*

Whey ratio (%)	Package type	Storage period	<i>L</i>	<i>a</i>	<i>b</i>
0 (control)	Plastic bag	1	66.79 a	0.67 d	21.11 c
		7	65.35 a	0.84 d	20.72 c
	Vacuum	1	66.41 a	0.33 d	20.66 c
		7	65.78 a	0.39 d	20.13 c
25	Plastic bag	1	64.33 ab	5.56 bc	30.17 ab
		7	63.59 ab	5.34 bc	30.07 ab
	Vacuum	1	62.83 ab	4.64 c	29.10 b
		7	62.56 ab	4.68 c	29.17 b
50	Plastic bag	1	57.24 c	10.61 a	30.22 ab
		7	55.38 c	10.56 a	30.09 ab
	Vacuum	1	58.83 bc	7.91 b	31.06 a
		7	58.39 bc	7.73 b	30.89 a
Storage average		1	62.74 a	4.95 a	27.05 a
		7	61.84 b	4.92 a	26.84 a
Whey level average		0	66.08 a	0.56 c	20.66 c
		25	63.33 b	5.06 b	29.63 b
		50	57.46 c	9.20 a	30.57 a
Package type average	Plastic bag		62.11 b	5.60 a	27.06 a
	Vacuum		62.46 a	4.28 b	26.84 a

*Numbers with the same letters in a column are not significantly different at $P > 0.05$.

value was lower. White colour intensity in baked kadayıf decreased with whey addition, and a 50% whey addition produced the lowest *L* value. The control and 25% whey-added samples were lighter. Significant differences were found between the control group and 25% or 50% whey-added samples in terms of the closeness to a white colour. With increasing amounts of whey in the formulation of tel kadayıf, the colour intensity of baked kadayıf also increased. Significant differences were found in storage, whey level, and package type (Table 4). Tel kadayıf samples with a 50% whey addition had a more distinctive red colour. The bright red colour of tel kadayıf with a 50% whey addition increased its desirability. The most suitable colour for baked tel kadayıf was obtained from a 50% whey level; it was vigorous, bright, and appealing (Table 4). Similar results were found in *L* and *a* values by Çakmakçı and Aydın (2001).

According to variance analysis results, the whey level had a much more significant effect on colour, sweetness, and general acceptability ($P < 0.05$) among the sensorial

qualities studied. No significant difference was found between the 25% and 50% whey level in terms of flavour, although the 50% whey level had the highest-rated flavour (Table 5). Duncan's multiple comparison test results revealed that there was no significant difference among whey addition levels in terms of texture. However, as far as the colour was concerned, 50% and 25% whey-added tel kadayıf produced more colour than 0% whey-added tel kadayıf. Similar results were found in bread by Ertugay et al. (1987). Although the same amount of sherbet was added to all samples, a great deal of sweetness in whey-added tel kadayıf was recorded by the panellists, and that could be attributed to the extra sweetness from the lactose present in whey. The high colour value of whey-added tel kadayıf desserts can also be attributed to the Maillard reaction occurring between lactose and proteins. No negativity was produced between the control and whey-added tel kadayıf desserts in terms of unusual taste or smell in the sensory analyses. In contrast, the panellists noted that as the whey addition level increased, tel kadayıf had a tendency to taste

Table 5. Sensorial analysis results of the tel kadayıf dessert samples.^{1*}

Whey ratio (%)	Package type	Storage Period (day)	Colour	Texture	Flavour	Sweetness	General acceptance	
0 (control)	Plastic bag	1	4.50 e	6.50 dh	7.50 eg	8.0 a	6.75 c	
		3	4.13 ef	6.63 cg	7.38 fh	7.88 ab	6.75 c	
		5	4.00 ef	6.50 dh	7.13 gh	7.75 ac	6.75 c	
		7	4.00 ef	6.25 eh	7.0 h	7.75 ac	6.63 c	
		Average		4.16 c	6.47 bc	7.25 c	7.84 ab	6.72 c
	Vacuum	1	3.75 f	6.25 eh	7.50 eg	8.0 a	6.75 c	
		3	3.88 ef	7.25 ad	8.13 ac	8.0 a	6.75 c	
		5	4.00 ef	7.0 ae	7.50 eg	7.96 a	6.88 c	
		7	3.88 f	6.75 bf	7.38 fh	7.88 ab	6.75 c	
		Average		3.88 c	6.81 b	7.47 b	7.96 a	6.78 c
	25	Plastic bag	1	7.50 bd	6.88 be	8.38 a	7.25 df	8.0 ab
			3	7.13 cd	6.0 fh	8.13 ac	7.13 dg	8.0 ab
			5	7.0 d	6.25 eh	8.0 ad	7.25 df	7.75 ab
			7	7.0 d	6.25 eh	7.75 cf	7.38 ce	7.63 ab
Average				7.16 b	6.34 c	8.06 a	7.25 df	7.84 ab
Vacuum		1	7.50 bd	7.50 ab	8.13 ac	7.50 bd	8.13 ab	
		3	7.25 cd	7.50 ab	8.13 ac	7.48 bd	7.88 ab	
		5	7.25 cd	7.38 ac	8.0 ad	7.50 bd	8.0 ab	
		7	7.25 cd	7.25 ad	8.0 ad	7.48 bd	7.75 ab	
		Average		7.31 b	7.41 a	8.06 a	7.49 bd	8.03 a
50	Plastic bag	1	8.50 a	5.75 h	8.0 d	7.0 eg	7.75 ab	
		3	8.13 ab	6.0 fh	8.25 ab	6.75 g	7.75 ab	
		5	8.0 ab	5.88 gh	8.13 ac	6.88 fg	7.50 b	
		7	7.63 bd	6.0 fh	7.75cdf	6.75 g	7.50 b	
		Average		8.06 a	5.91 d	8.03 a	6.84 fg	7.62 b
	Vacuum	1	8.13 ab	7.75 a	7.63 df	7.0 eg	8.13 ab	
		3	8.0 ab	7.13 ad	8.13 ac	7.0 eg	7.63 ab	
		5	7.75 bc	7.25 ad	7.88 be	7.12 dg	7.63 ab	
		7	7.63 bd	7.50 ab	7.88 be	7.0 eg	7.50 b	
		Average		7.88 a	7.41 a	7.88 a	7.03eg	7.78 ab
Storage average		1	6.65 a	6.77 a	7.85 a	7.46 a	7.58 a	
		3	6.42 ab	6.75 a	7.91 a	7.38 a	7.56 a	
		5	6.33 b	6.71 a	7.77 ab	7.42 a	7.42 ab	
		7	6.22 b	6.67 a	7.62 b	7.38 a	7.29 b	
Whey addition average		0	4.02 c	6.64 a	7.36 b	7.91 a	6.75 c	
		25	7.23 b	6.87 a	7.95 a	7.36 b	7.94 a	
		50	7.97 a	6.66 a	8.06 a	6.94 c	7.70 b	
Package average		Plastic bag	6.45 a	6.24 b	7.78 a	7.31 b	7.40 a	
		Vacuum	6.36 a	7.21 a	7.80 a	7.50 a	7.53 a	

¹Sensory analysis scores (1: poor, 9: excellent).

*Numbers with the same letters in a column are not significantly different at P > 0.05.

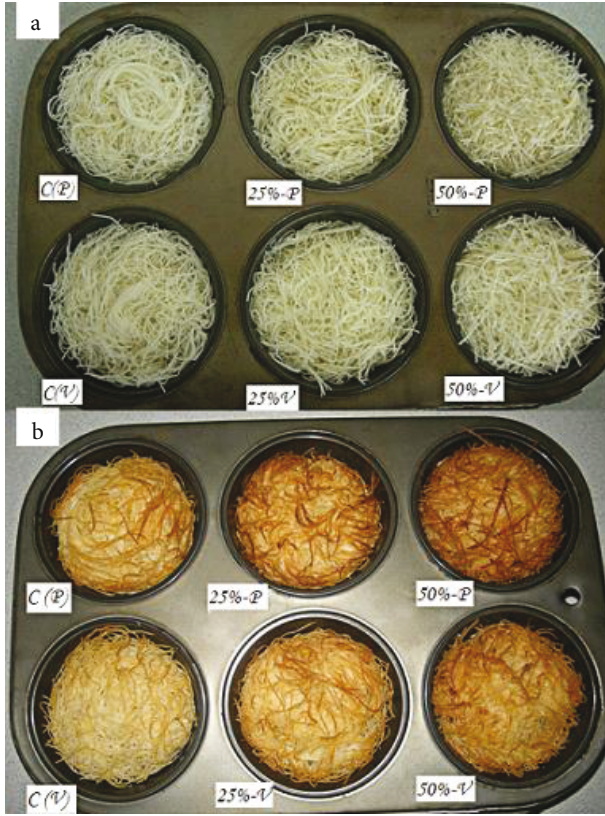


Figure 1. Appearance of fresh tel kadayıf samples (a) and those fried for an equal amount of time (b); C (P): control sample in plastic bag; C (V): control sample in vacuum pack; 25%-P: 25% whey added, stored in plastic bag; 25%-V: 25% whey added, vacuum packed; 50%-P: 50% whey added, stored in plastic bag; 50%-V: 50% whey added, vacuum packed.

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similar to tel kadayıf with cheese (Çakmakçı and Aydın, 2001); it had a new taste. There is no significant difference among the tel kadayıf desserts made from fresh and stored raw kadayıf in terms of sensorial criteria (Table 3). The highest general acceptability scores were obtained with 50% whey addition level samples, although there were no significant differences between the package types.

When the research results were evaluated collectively, it was found that baking time was shortened with the use of fresh whey at different levels in place of water in tel kadayıf production, and the sweetness of the dessert increased. Compared to the control, less electrical energy and sugar were needed when whey was used at a certain level in the production of tel kadayıf. It was also found that the dry matter, milk fat, and protein in tel kadayıf with whey addition, and the whey itself, increased the nutritional value of tel kadayıf.

In conclusion, a 50% whey addition level may provide the most positive sensorial and technological quality characteristics in tel kadayıf desserts according to the collective evaluation of the research findings. Research topics such as additive level, sugar content, and energy savings are still required. In addition, raw tel kadayıf samples can be stored safely in vacuum packages or plastic bags in the refrigerator for 7 days.

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