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Modification and sensory evaluation of Turkish delight (lokum); supplemented with different levels of dried date powders

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Abstract

Thise current study aimed to investigate the impacts and sensory properties of replacing gelatin in Turkish delight with starch and dried date powder (DDP) for the development of new products. Nine different concentrations of fluid mucilage were used: Sample 1 (90% gelatin + 10% starch); Sample 2 (90% gelatin + 5% starch + 5% DDP); Sample 3 (85% gelatin + 10% starch + 5% DDP); Sample 4 (80% gelatin + 20% starch); Sample 5 (80% gelatin + 10% starch + 10% DDP); Sample 6 (75% gelatin + 20% starch + 5% DDP; 70% gelatin + 30% starch); Sample 7 (70% gelatin + 15% starch + 15% DDP); and Sample 8 (65% gelatin + 30% starch + 5% DDP) in addition to a control sample (Sample 9, 100% gelatin). Consistency, texture, and tenderness of all samples (gel and water activities; a_w) were evaluated in terms of taste, aftertaste, and overall acceptability. The sensory panelists' scores of collected data showed significant differences between all measured parameters for all compared to with the control sample, but the best products were with samples with added (DDP) at low levels. In conclusion, replacing gelatin with starch and (DDP) should be at low levels.

Keywords: fluid mucilage; consistency; appearance; texture; tenderness and acceptability.

Practical application: The practical application is to Ddeveloping new innovative Turkish delight products supplemented with date powder (DDP) and starch instate of gelatin levels to enhance the lokum nutritional value suitable for the Arabic cultures and markets.

1 INTRODUCTION

Turkish delight (lokum) is a well-known confection that is sugar-based jelly-like, delicately chewy,, and perfectly sweetened, and includes a starch gel or it has been known as a family of confectioneries based on both starch and sugar gel. It has been recognized since the fifteenth's century and has since become the oldest sweet worldwide (Batu & Arslan, 2014; Doğan, 2008). Turkish delight is often eaten as small cubes with soft and sticky consistency; therefore, it is packaged and icing sugar was is used to reduce stickiness and prevent chewing issues (Batu & Kirmaci, 2009; TGK, 2004). More recent data have mentioned that both production and taste change with the presentation of sucrose and purified starch. Turkish delight was prepared from a combination of honey and flour and then developed with flour and starch additions (Batu & Arslan, 2014). Regarding the production development process within the twentieth's century, many sources of food additives, supplements, and flavors such as lemon, or some other fruit extraction and nuts (e.g., pistachio, hazelnut, or walnut) have become available for producing more types affecting its consumption levels. For example, Batu (2006) and Gönül (1985) have replaced honey and grape molasses, which is a well- known traditional sweetening ingredient, with the newly available refined sugar. Moreover, the gel former with lokum is a mixture of sugar and gelatin that is responsible for gel formation after being cooked or dissolved in hot water and should not be sticky or hard chewing. Gelatin, with its amino acid profile that still binds together, is the same as collagen hydrolysate, with different chemical properties (Batu & Arslan, 2014). It is a luxurious Turkish sweet dish that is more common in some countries, such as Armenia, Greece, Romania, and Russia, and most Arabic countries, mainly Saudi Arabia and Egypt.

Saudis are the world's top daily date consumers.; Saudi Arabia was the largest second date producer for 2018-–2019, with a total date production of 1,483,631 tons (Alharbi et al., 2021). Date fruit consumption in various types and shapes is an important food/component of the consumed daily diet within their traditional and dietary habits in all life levels.; aAbout 3-5 dates are perfect to break their fast daily and also to be consumed early morning (Mirghani, 2021; Sidhu, 2012). Additionally, date fruits were are shown to have many health benefits because they are high in their phytochemicals levels in contrast to very low fat levels decreasing the cholesterol levels that have been associated to low risk levels of heart diseases in addition to their dietary fiber levels (Khalil et al., 2023). Different studies have used such date fruit fibers in different human health products,. e.g.,For example, a study by Aljutaily et al. (2022) illustratesd the anti-obesity effects of new innovative biscuits supplemented with date's fiber as a potent functional food because of their nutritional values (Aljutaily et al., 2022). However, Turkish delight production has not been developed or even studied with either fresh or dried

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date powders (DDP), especially to fit Saudi consumers' considerations. Thus, the this current study is a new and original study designed to investigate the effects of date powder additions/replacement with starch on Turkish delight properties. Therefore, the most important features used in the this current research on Turkish delight are the starch-like stabilizing capabilities, as well as cost savings with new natural and healthful goods (Bensadon et al., 2010). In addition, the quality parameters measured for any food product property are the evaluations of any microbial, textural, physical, chemical, and/or physicochemical analyses. However, further analyses, such as processes applied, storage conditions, and packaging systems, could be much more effective on storage stability based on the physical, chemical, and moisture characteristics of the food (Ergun et al., 2010). There is very little less information available in the published literature about the physical or textural properties of Turkish delight (lokum). As a result, the purpose of this work was to investigate the physical and sensory properties of various Turkish delight samples supplemented with varying concentrations of starch and dried date powders (DDP) in place of gelatin levels, and various physical parameters such as consistency, texture, and water activity (aw) were determined. Dried date powder (DDP) has not before been employed earlier in such freshly developed products;, and consequently, the this current study is the first to use it due to its significant nutritional value.

2 MATERIALS AND METHODS

The Turkish delight control sample and dried date powders (DDP), as well as all necessary ingredients, were obtained from a local market in Jeddah, Saudi Arabia.

2.1 Experimental Turkish delight samples design and preparation

The Turkish delight sample was created using the method given byin (Foods and Cookery, 1991), with some alterations. For the control samples, dextrose (3 cups) and water (150 mL) were mixed and stirred in a saucepan, and 1 teaspoon of lemon juice was added over a low heat after gelatin or other supplemented additions. Different starches and dried date powders (DDP) were replaced with the control sample containing 100% gelatin. Nine different formulations were prepared by replacing the percentage of gelatin with different concentrated starch and dried date powdersDDP as follows. Sample 1 contained 90% gelatin + 10% starch; sample 2 contained 90% gelatin + 5% starch + 5% DDP; sample 3 contained 85% gelatin + 10% starch + 5% DDP; sample 4 contained 80% gelatin + 20% starch; sample 5 contained 80% gelatin + 10% starch + 10% DDP; sample 6 contained 75% gelatin + 20% starch + 5% DDP; while and samples 7, 8 and –9 contained 70% gelatin + 30% starch; 70% gelatin + 15% starch + 15% DDP; and 65% gelatin + 30% starch + 5% DDP, respectively. The lowest concentration of gelatin used in the formulations was 65% as shown in Table 1.

Afterward, Aall the mixture afterwards was gradually boiled until the syrup reached to the boil-stirring. They wereIt was rinsed with a wet pastry brush to prevent big crystals from forming in the syrup, and and the mixture was boiled for approximately 25 min. until it reached 115°C (soft ball stage). Corn flour was added and mixed into cold water gradually, then low heat was adjusted, and the mixture was constantly stirred constantly until it became reached the thickensed and then removed from the heat. The mixture was stirred to obtain a smooth mixture and then returned to heated again to obtain a thick gluey paste. Notably, ½ half of the dextrose syrup was added to the gelatin paste and stirred thoroughly and then one-fourth of the remaining syrup 1/4 was added. Once a spoon drawn across the base leaves a line, the mixture is was stirred by flavoring and coloring, removed from heat, and placed into a tin (we used a loaf tin 8 cm ×19 cm) lined with greased cling wrap or baking paper. Finally, it was placed on a bench (not in the fridge) to set (tooake several hours), cut with a sharp knife into small squares, rolled in dextrose, and kept in an airtight container at room temperature with a small amount of dextrose powder. All samples were divided into 1 × 1 × 1 cm cubes and rolled in a corn flour and icing sugar mixture (Foods and Cookery, 1991).

Table 1. The concentration of different modified formulations with dried date powder of Turkish delight.

Samples	Modified Formulations %		
	Gelatin	Starch	Dried date powder
Control	100	----	----
1	90	10	-----–
2	90	5	5
3	85	10	5
4	80	20	-----–
5	80	10	10
6	75	20	5
7	70	30	-----–
8	70	15	15
9	65	30	5

2.2 Sensory evaluation by consumer panel

The Research Ethics Committee (REC) (Reference no. 255-23) examined and approved all study procedures, and all subjects gave their informed permission. Twenty consumers who were semi semi-trained panelists (10 males and 10 females) aged 25 to –40 years, were used involved for the sensory evaluations from King Abdelaziz AbdulAziz University, KSA,. Participants were asked to score each sensory feature using the control samples as the foundation for evaluation using a modified questionnaire created according to a prior study (Ivanišová et al., 2020). The samples were examined concurrently, and bottled water was used as a palate cleanser between them. Overall acceptability was measured using a standardized 9-point hedonic scale, with values ranging from 1 (very dislike) to 9 (strongly like) for each characteristic (Hooda & Jood, 2005).

2.3 Physical analysis

2.3.1 Consistency

As detailed by Du Toit et al. (2016), a piece of paper with concentric circles written at 0.5 5-cm intervals was placed on the

bottom of a glass plate. In the center of the circles, an open-ended tube (2 × 2 cm) was put and filled with 5 mL of the liquid sample, which was allowed to flow for 2 minutes. The distance was then measured at each 90° portion of the circle, and the average was determined;. tThe line spread value (LSV) was the mean of the four values obtained, and itwhich was expressed in centimeters (Kim, 2007).

2.3.2 Texture

The comparative tenderness and penetration properties were assessed using a penetrometer and the cone penetration test (ASTM D217), as previously described (Du Toit et al., 2016; Mohos, 2010). The more tender the sample, the higher the reading. Furthermore, the deeper the penetrometer that sinks into the sample, the higher the penetration value with more compression achievement suggesting a tenderer softer product. The results are given in millimeters.

2.3.3 Tenderness of gel

The percentage sag test was used to measure gel tenderness, which was represented as a percentage of height. As previously disclosed (Du Toit et al., 2016), the depth of the samples was determined using a probe in its container. The depth was measured again once the sample was unmolded onto a flat surface. The percentage sag was then computed as the difference in height between the sample in the container or mold and the freestanding gel placed on a flat surface. The more delicate the gel is, the higher the percentage sag value (McWilliams, 1989).

2.3.4 Water activity (a_w)

The water activity of ten 10 samples enriched with dried dates fruit powder was determined in aw containers (height of 5 mm and diameter of 39 mm) at room temperature (20°C) using the procedures published previously by Landrock and Proctor (1951). At 20°C, the samples (in little plastic cups) were equilibrated with a saturated salt solution.

2.4 Statistical analysis

The one-way analysis of variance (ANOVA) approach were was used to identify the various study parameters. The Duncan's multiple range post-hoc test was then used to examine differences between pairs of means. At the $p < 0.05$ level, this test was judged statistically significant. T-test: To ascertain the impact of gender, a two two-sample t-test was conducted (Snedecor & Cochran, 1980).

3 RESULTS AND DISCUSSION

3.1 Effect of different levels of dried date powderDDP on sensory properties between males and females

The This current study was conducted to measure the sensory and acceptable analysis of differently prepared Turkish delight that was supplemented with different date fruit dried powders in addition to starch at different levels as a replacement for gelatin. Firstly, Table 2 illustrates the liking of sensory properties (i.e., taste, sweet aftertaste, texture, and overall acceptability) of the prepared Turkish delight samples within gender groups.

Only a statistically significant difference ($p = 0.0124$) in aftertaste preference between the genders was observed.; mMen gave aftertaste preference a higher rating than women (8.90 vs. 8.03, respectively). Additionally, a sweet aftertaste was added to see if customers could notice the grassy aroma (Rothman et al., 2012). Hoffman et al. (2016) found that male consumers find sugar more pleasant at higher concentrations, such as in confectionaries, compared with female consumers. However, only 50% of the panelists in the this current study belonged to the male group, which is still a valid result.

3.2 Effect of different levels of dried date powderDDP on the taste, aftertaste, texture, and over all acceptability

Table 3 revealed reveals the effects of the dried date powderDDPs in addition to starch supplemented to the Turkish delight samples, on the liking of taste, aftertaste, texture, and overall acceptability.

It has been shown that the best samples taste both with the highest scores at 8.24, and 8.01 that were found with samples numbered 1 and 4 that which hasve gelatin and starch only (90% + 10% and 80% + 20%, respectively). The tastes of both samples were not significantly different from that of the control sample (8.16). The lowest two samples were counted for numbers samples 8 and 9, which contained 70% gelatin + 15% starch + 15% DDP and, 65% gelatin + 30% starch + 5% DDP, respectively. Samples numbers 2 (90% gelatin + 5% starch + 5% DDP) and 7 (70% gelatin + 30% starch) showed a statistically significant difference compared to with the all-prepared samples (7.22, and 7.41, respectively). Thus, the samples supplemented with starch at different levels were successful in producing the grassy flavor which is in agreement with previous data collected from (Rothman et al., 2012). Samples supplemented with different percentages of starch are preferable, and such data are in agreement with (Du Toit et al., 2016).

Regarding the aftertaste evaluation, it can be noticed from the same table that samples 1, and 4 nearly gave the same levels (8.08 and 8.01, respectively) with no significant differences from the control sample (8.20), while samples 2 and 7 were nearly the same with significant differences (7.28 and 7.27, respectively; $P < 0.05$). Additionally, sample number 3 was significantly different from all the measured samples: with 6.50. In contrast, data with low aftertaste levels are presented (3.23, 3.47, 5.37, and 5.47) for samples 8, 9, 6, and 5, respectively.

Table 2. Effects of gender groups on the liking of sensory properties for modified Turkish delight*.

Sensory properties	Female	Male	*P*-value
Taste	8.03 ± 2.05	8.90 ± 1.64	0.0879
Sweet aftertaste	8.26 ± 1.98 [a]	8.88 ± 1.63 [b]	0.0124
Texture	8.11 ± 1.72	8.65 ± 1.78	0.0566
Overall acceptability	8.39 ± 0.29	8.86 ± 1.59	0.0742

*Means with different superscript letters in the same row different significantly according ato the two two-sample t-test.

Again, for the overall acceptability, all the samples indicated significant differences from the control sample except the firstsamples 1 and fourth 4 samples again ($P < 0.05$);. iIt has been noticed that sample number 1 has the highest acceptability even more than the control samples (8.38 vs. 8.2 %, respectively). For all modified samples, we can see that all samples in order from the maximum acceptability to the minimum are ranked as follows:

1 < 4 < 2 < 7 < 3 < 5 < 6 < 9 < 8

Thus, over all recommended DDP used levels should be preferred samples with the nearest to the control and that have been found with the ones supplemented by the lowest DDP levels, as shown in sample 2 (5% DDP only) followed by sample 3;, which is, again, 5% DDP replacement. On the other handcontrary, samples supplemented with the highest DDP levels were chosen to be preferred or within the overall acceptability at the end (e.g., sample 8).

3.3 Effect of different levels of DDPdried date powder on consistency, texture, tenderness, and water activity properties

All of these proprieties are affected by different levels of DDPdried date powder added to Turkish delight samples presented in Table 4. Replacing different percentages of gelatin with starch had significant ($P < 0.05$) effects on all physical parameters evaluated here in Table 4. The line spread test resulted in the lowest value with sample (1) which had a significant ($P < 0.05$) formulation of consistency with all the other samples in Table 4). Again, the consistency levels were ordered as follows compared to with the control sample were ordered as follows:.

1 > 7 > 2 > 4 > 3 > 5 > 6 > 9 > 8

sSample 8 (70% gelatin + 15% starch + 15% DDP) had the highest value significantly ($P < 0.05$) for the line spread test, indicating that it was the most consistent among all other samples in Table 4. Starch was mixed with gelatin only in samples 1, 4, and 7, which produced low levels of line spread test, indicating that this could be responsible for the low consistency levels because of its solubility and strength. Overall, increasing the percentile levels of DDP addition resulted in high consistency levels that have been provided previously (Nussinovitch, 1997).

Additionally, Table 4 presents the tenderness of gel levels affected by the levels of DDP supplementation in the Turkish delight samples. The greatest significant ($P < 0.05$) effect with all measurements was found with samples numbers 9 and 4 (28.08, and 26.30%, respectively) that had 30% guar gum and 20% starch additions, which means they were tender compared to with all the samples. However, the samples with the lowest readings were 7, 8, and 2, indicating that these samples were less tender in Table 4. Additionally, McWilliams (1989) demonstrated that a tender product will penetrate deeper to produce a higher penetration value, demonstrating that the larger the reading, the more tender the product. AgainOnce more, the control sample, which had

Table 3. Effect of different levels of dried date powder on the sensory properties of the Turkish delight delight-modified samples*.

Sample	Taste	Aftertaste	Appearance	Overall Acceptability
Control	8.16 ± 1.06 [a]	8.20 ± 2.43 [a]	8.63 ± 2.08 [a]	8.21 ± 2.05 [a]
1	8.24 ± 2.82 [a]	8.08 ± 1.85 [a]	8.18 ± 1.18 [a]	8.38 ± 1.26 [a]
2	7.22 ± 2.40 [b]	7.28 ± 1.49 [b]	7.20 ± 1.05 [b]	7.38 ± 1.02 [b]
3	6.37 ± 0.04 [c]	6.50 ± 1.49 [c]	5.36 ± 2.10 [c]	6.22 ± 1.13 [c]
4	8.01 ± 0.08 [a]	8.01 ± 1.51 [a]	8.48 ± 1.12 [a]	8.10 ± 1.0 [a]
5	4.11 ± 1.32 [d]	5.47 ± 1.00 [d]	5.42 ± 1.04 [d]	5.48 ± 0.23 [d]
6	5.41 ± 1.22 [d]	5.37 ± 1.20 [d]	5.52 ± 0.4 [d]	5.22 ± 0.11 [d]
7	7.41 ± 1.32 [b]	7.27 ± 1.04 [b]	7.82 ± 1.84 [b]	7.35± 1.86 [b]
8	3.31 ± 1.62 [e]	3.23 ± 0.32 [e]	3.02 ± 0.74 [e]	3.02 ± 0.28 [e]
9	3.41 ± 1.02 [e]	3.47 ± 0.20 [e]	3.82 ± 0.24 [e]	3.38 ± 1.08 [e]

*Means with different superscript letters in the same column are significantly different, ($P < 0.05$).

Table 4. Effect of different levels of dried date powder on the consistency, texture, tenderness, and water activity properties of the Turkish delight samples*.

Samples	Consistency (cm)	Texture (mm)	Tenderness of gel (%)	Water activity (a_w)
Control	1.87 ± 0.02 [c]	0.23 ± 0.33[f]	0.86 ± 1.01[e]	0.77 ± 0.11[b]
1	1.32 ± 0.06 [f]	0.67 ± 0.02 [d]	9.08 ± 1.10[c]	0.77 ± 0.15[b]
2	1.86 ± 0.05 [c]	1.11 ± 0.41 [c]	9.60 ± 3.08[c]	0.78 ± 0.31[a]
3	2.04 ± 0.24 [b]	0.50 ± 0.02 [e]	19.74 ± 1.66[b]	0.75 ± 0.21[c]
4	1.88 ± 0.05 [c]	0.53 ± 0.07 [e]	26.30 ± 6.41[a]	0.76 ± 0.01[b]
5	2.05 ± 0.21 [b]	1.32 ± 0.05 [b]	9.64 ± 1.20[c]	0.79 ± 0.01[a]
6	2.17 ± 0.02 [a]	0.52 ± 0.08 [e]	8.75 ± 1.55[c]	0.75 ± 0.11[c]
7	1.73 ± 0.21 [d]	1.80 ± 0.05 [a]	5.31 ± 0.96[d]	0.74 ± 0.31[d]
8	2.23 ± 0.17 [a]	0.80 ± 0.19 [c]	15.28 ± 2.08[b]	0.76 ± 0.04[b]
9	2.22 ± 0.07 [a]	0.80 ± 0.13 [c]	28.08 ± 2.63[a]	0.77 ± 0.31[b]

*Means with different superscripts in the same column differ significantly ($P < 0.05$).

a strong gel texture due to the gelatin component, received the lowest percentage score.

Turkish delight samples' water activity (aw) characteristics are displayed in Table 4. The average weight of all samples was between 0.74 and 0.79, putting them all in the category of intermediate moisture foods (IMF), which are mostly protected from microbial deterioration by having an aw between 0.65 and 0.85 (Garbutt, 2007). Once moreAgain, sample 7 had the lowest aw value (0.74), which differed significantly ($p < 0.05$) from all the other samples. On the other handcontrary, sample 5'sthe greatest aw of 0.79 of sample 5 differed considerably ($p < 0.05$) from all other values.

4 CONCLUSIONS

To conclude, tThe best textural attributes with of Turkish delight were associated with samples 2, 4, and 7, consisting only of gelatin + starch followed by the samples replaced by 5% dried date powder (DDP) in all the above-mentioned measured activities, so the replacement of gelatin with starch and DDP should be at low levels. However, more products require further biological and microbiological analyses in addition to life- shelf examination.

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