Journal of Food Science and Technology (Iran)

Homepage:www.fsct.modares.ir

Scientific Research

Studying the application of date wastes in order to prepare a kind of jelly candy and evaluation of its quality and sensorial properties

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ABSTRACT

Nowadays, the increasing demand for healthy foods has led to application of natural ingredients such as fruits in the formulation of food products. In this study, date waste (grade two) has been used in the formulation of a kind of nutritious jelly candy (up to 30%) with substitution of agar gum instead of gelatin (0, 15, 25 and 35%). Then physicochemical properties (moisture, dry matter, total ash, water activity, and color indices), texture characteristics (hardness, adhesiveness, springiness, stringiness and fracturability) and sensorial properties of the samples were analyzed and one-way ANOVA test at significant level of 95% was used for statistical analysis. The result showed that addition of date puree into jelly candy formula decreased moisture content, *L** and *b**, significantly ($p<0.05$) while total ash, *a**, adhesiveness and stringiness showed an increasing manner ($p<0.05$). But effect of adding date puree on water activity and other texture characteristics including hardness, springiness and fracturability was not significant ($p>0.05$). Substitution of gelatin with agar (to 35%) resulted to decrease in moisture content and increase of total ash, color parameters and texture characteristics ($p<0.05$) while its effect on the other texture characteristics and water activity was not significant ($p>0.05$). The result of sensory evaluation indicated that the jelly candy containing 100% gelatin (agar free) recognized as the best specimen because of obtaining the suitable physicochemical properties and desirable texture.

ARTICLE INFO

Article History:

Received:2021/6/2
Accepted: 2022/12/31

Keywords:

Date waste,

Agar,

Jelly candy,

Functional food.

DOI: 10.22034/FSCT.20.139.14
DOR: 20.1001.1.20088787.1402.20.139.2.6

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1- Introduction

Jelly candies[1] They include a large group of confectionery products such as pastilles, jellies, etc., in which a gelling agent such as gelatin, pectin or starch is added to a sugar syrup.[1]. In jelly candies, the gelling compounds are selected according to the desired texture characteristics (soft or hard texture), which usually the final texture of these products is elastic, springy, non-sticky, durable and interconnected [2-3]. On the other hand, in recent years, the production of nutritious and healthy food products such as snacks[2]Fruits have received a lot of attention, especially for children. snackFruits are easy to eat, have a long shelf life, are pleasing to the eye, have a good mouthfeel, and are also beneficial for health. Due to the fact that in the production of fruit snacks even second and third grade waste fruits can be used, therefore, the food industry can have a tremendous impact in reducing waste and increasing the added value of agricultural and horticultural products [4]. Until now, various researches have been conducted regarding the use of various fruits and vegetables in the formulation of jelly candies as a kind of fruit snack. From strawberry puree [5], apple [6], tropical fruits (pineapple, banana, passion fruit[3][7], pomegranate [8], mango [9], pumpkin [10], cantaloupe [11], plum [12], carrot [13], tomato [14] and kiwi [15] in the formulation of jelly candies Used.

Date with scientific name*Phoenix dactylifera*، Rich source of simple sugars, minerals, vitamins and dietary fiber[4] is considered[16-17] thatOur country, Iran, is one of the largest producers of dates in the world, with the production of about 1.3 million tons of product per year (according to the statistics of 1400).]18[. YetLittle documented research is available on date chemistry, its nutritional composition, as well as the processing and application of date by-products.[16] and Due to the lack of necessary facilities to process dates into various products and also the lack of suitable packaging, generally a large amount of this valuable product is sold at a low price as waste dates or second and third grade dates. In the present study, an attempt was made by adding date puree (prepared fromWaste dates) in the formulation of jelly candies, a new type of nutritious snack based on agar should be prepared, so as to take a step towards reducing date waste and creating added value from it.

2- Materials and methods

2-1- Raw materials

The dates used in this research were second-grade dates (dates that are not desirable for consumers) of the Shahani variety belonging to Jahorm city (Fars province), which was purchased from one of the reputable stores in Tehran and immediately refrigerated at 4 degrees. Celsius was transferred. The gelatin used is bovine gelatinB With bloom value of 240-260 and light yellow crystalline appearance, it was prepared from Halal Gelatin Pharmaceutical Technology Company (Tehran, Iran). Agar gum with a particle size smaller than 315 micrometers from the companyMerck Germany was bought. Glucose syrup consumed withOF 41.66, dry matter 79.27% andpH 4/66 with a clear and colorless appearance, as well as dextrose monohydrate powder, were prepared from Iran Dextrose Company.

2-2- Preparation of date puree

In order to prepare date puree, first the date fruits were peeled manually and hygienically and then pitted, and in the next step, using a home blender (Feller, ModelFPB22W, made in Germany) were turned into puree[11-12]. The color of date fruits became a little brighter after turning into puree, and the resulting texture was very soft, fluffy and uniform. In the last step, the prepared puree was enzyme-treated to prevent any unwanted biological and chemical reactions. Enzyme removal was done using a hot water bath (Fan

[1]- Gummy candies
[2]- Snack
[3]- Passion fruit
[4]- Dietary fiber

Azma Gostar, made in Iran) with a temperature of 75 degrees Celsius for 5 minutes and manual stirring [19]. Finally, after cooling at room temperature, the puree was transferred to containers with lids (polyethylene, size 20 x 20) and stored in the refrigerator for two days.

2-3- Preparation of jelly candies

The default formulation defined for this research included the use of 60% date puree, 15% sweetener, 5% gelatin and replacing agar instead of gelatin at the levels of 0, 25, 50, 75 and 100%, which according to the preliminary results obtained, Since it was not possible to add more than 30% of date puree in the formulation (due to the creation of a completely sticky and non-uniform texture) and also the most substitution of gelatin with agar gum at the level of 35% was possible and good results followed, so considering Based on these results and relying on the optimal production conditions, while maintaining the physicochemical and sensory characteristics of the product, the final formulation was determined according to Table 1. The components of the final formulation include 30% date puree, 15% sweetener (8% sugar, 5% glucose syrup and 2% dextrose powder), 6% gelatin and agar gum at four levels of 0, 15, 25 and 35% as alternatives. They were gelatin. Also, a control sample that did not contain date puree and agar was also prepared as a criterion for evaluating the qualitative and quantitative characteristics of the samples.

Table 1 The ingredients of jelly candy formulation (100 g)

Treatment code	Date puree (g)	Gelatin (g)	Agar (g)	Sucrose (g)	Glucose syrup (g)	Dextrose powder (g)	Water (g)
Control	0	6	0	8	5	2	79
A0G100	30	6	0	8	5	2	49
A15G85	30	5.1	0.9	8	5	2	49
A25G75	30	4.5	1.5	8	5	2	49
A35G65	30	3.9	2.1	8	5	2	49

The letters A and G representing, respectively, agar and gelatin and also the numbers are showing the percentage of substitution.

The method used to prepare jelly candy samples is shown schematically in Figure 1[20, 15]. For this purpose, at first, the distilled water needed to reach the temperature of 90 degrees Celsius was heated in a hot water bath. This work is especially necessary in the case of agar, which is insoluble in cold water [21] and requires temperatures higher than 80 °C to dissolve [22]; Besides, the dissolution of gelatin was done more easily at this temperature. Then gelatin and agar hydrocolloids were gradually added to distilled water with the help of a magnetic stirrer. Gelatin forms a light yellow transparent gel after dissolution, which may contain air bubbles, for this purpose, aeration was done using a hot water bath at a temperature of 90 degrees Celsius for 12 minutes [23]. Next, the required amount of date puree and sweetening compounds were gradually added to it. Then this mixture was heated for 15 minutes in a hot water bath with a temperature of 60 degrees Celsius for better mixing. Then the baking process was done at 90 degrees Celsius for 5 minutes and the prepared mixture was transferred into silicone molds and kept in the refrigerator (4 degrees Celsius) for 24 hours to seal the gel. The resulting gels were then removed from the molds and dried at room temperature for 72 hours.

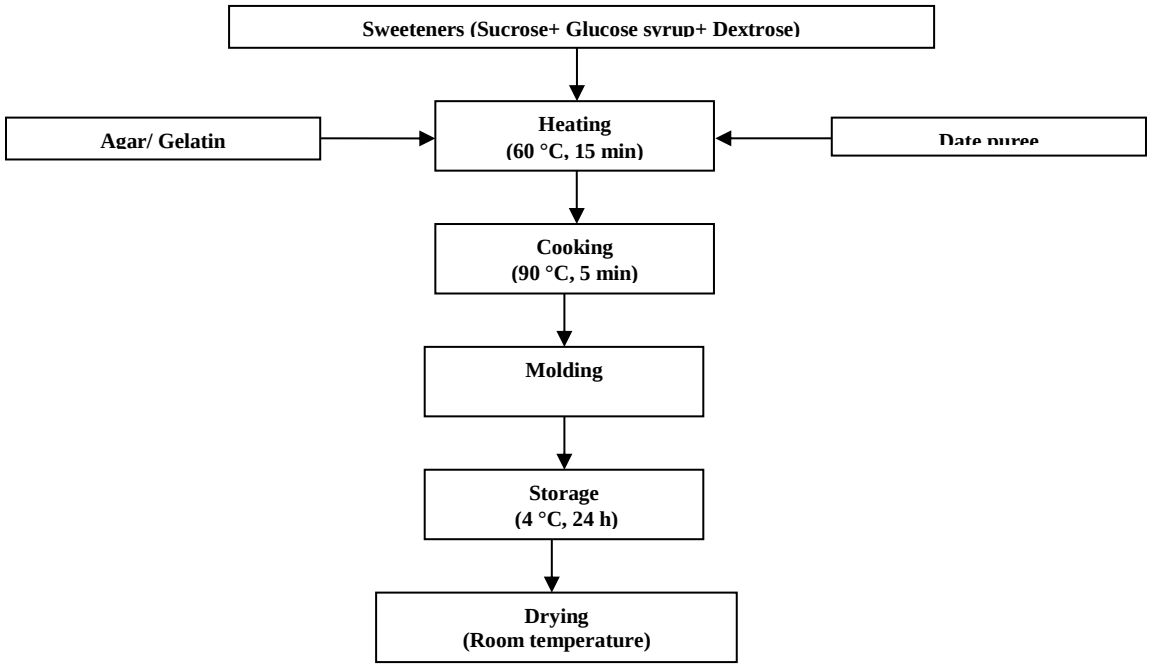


Fig 1 The flow diagram of jelly candy production

2-4- Physicochemical tests of jelly candies

At firstpHDate puree and jelly mixtures (before setting the gel) with helppHdigital meterOrion, ModelA420, made in USA) was measured. Next, to measure the total ash, the Chinese plants were first put in the oven for 30 minutes.Exciton, Model1200-2L.Ex, made in Iran) were placed at a temperature of 550 degrees Celsius to reach a constant weight. After cooling and weighing the plants, 5 grams of date puree or jelly candy were weighed inside the plants and burned on a direct flame until a black mass of the sample was left. At this stage, the bushes were placed in the oven at a temperature of 550 degrees Celsius and when white ash from the samples remained inside each bush, the bushes were weighed and the total ash percentage was calculated by dividing the weight of the ash by the initial weight of the sample. [24]. To perform the moisture test, first weigh 3 grams of the sample in the weighing plate and put it in the oven.Wise- ven, ModelWOF-50, made in Germany) were transferred at a temperature of 110 °C until they reach a constant weight. The moisture percentage of date puree or candy jelly samples was calculated by the difference of the initial weight of the sample from the dry weight [25-24]. The amount of dry matter remaining after removing the moisture refers to the total solids, which is obtained from the difference of the amount of moisture from the number 100.

The amount of moisture alone is not enough to express the qualitative characteristics and shelf life of gel products, and water activity is an important parameter that is often used to express microbial stability and texture characteristics. The product is used [26]. In this test, the crushed and uniformed samples are weighed and placed in the special cell of the machinea_{In}gauge (Novasina, ModelTH-500, made in Switzerland) were poured so that half of the tube is filled with the sample and half of its height remains empty. In the next step, after the water vapor pressure was fixed, the

amount of water activity was read on the screen of the device at a temperature of 25 degrees Celsius [27, 20].

The color of food surface is the most important factor in rejecting or accepting food. Color identification can be done by human senses or by physical means [28]. ModelLab which has the most complete color spectrum, in 1976 by the International Illumination Commission (CIE[5]) was recognized as an international standard for color measurement. Color modelLab Composed of brightness or transparency component[6] (L^* which has skirts from zero to 100) and two color components (with skirts from -120 to +120) includinga^* (with green to red color spectrum) and componentb^* (has a blue to yellow color spectrum) [29]. In this research, to prepare the samples, round molds with a larger surface area were used than the optical spectrum plate[7] colorimeterKonica Minolta, ModelCR-400, made in Japan) completely match the level of the sample. Then, color images are taken from the sample and after converting the images into data, the valuesL^* ،a^* Andb^* It was recorded on the device screen.

2-5- **Histological test** Jelly candies

From the texture profile analysis test (TPA[8]) is widely used to determine the texture characteristics of food products, in which the texture of the sample can be measured by placing the food under a constant force through deformation or flow, with a combination of mass, distance and time measurements. In this research, the instrumental method of tissue profile analysis (Testometric, Model M350-10CT, made in England) was used for this purpose, at first the samples in dimensions 1.52×2 (length×width×thickness) were cut and then fixed on the lower jaw of the device. The loading rate of the device was set to 5 kg (50 N) in two round-trip cycles (two round and two round), by the upper movable jaw with dimensions of 7 x 7 cm and a movement speed of 60 mm/min up to 50% of the height. The initial sample (1 cm) was compressed and then decompressed]13-12[. Then, with the help of the device software and the force-time curve drawn by it, some textural characteristics of the samples such as adhesion, hardness, elasticity, fragility, etc. were extracted and analyzed.]12 ،14[.

6-2- Sensory evaluation of jelly candies

Sensory analysis is often used in the formulation phase of new products or optimization of existing products [30]. Sensory evaluation in this research was done by 30 people (13 men and 17 women, in the age range of 25 to 55 years) by a trained evaluator [12]. In order to evaluate samples from the 5-point hedonic scale [11, 31] were used, in which scores from 1 to 5 indicated very bad, bad, average, good and very good characteristics, respectively [32].

[5]- International Commission on Illumination
[6]- Luminance or Lightness
[7]- Spectrum
[8]- Txture Profile analysis

For this purpose, samples with the same dimensions along with a questionnaire were provided to each person and they were asked to give their opinions regarding 10 sensory attributes, including appearance, color, firmness, after chewing and swallowing completely.[9]Being rubbery[10], chewability, stickiness, surface moisture[11], apply sweetness, taste (smell and taste) and general acceptance in the questionnaire and drink some water before testing the next sample.

2-7- Statistical analysis

All tests were repeated at least three times for statistical analysis of the data from the softwareSPSS (4th edition) and statistical analysis methodOne-way ANOVA was used and if there is a significant difference between the variables at the 95% confidence level (0.05>P), TestDuncan Was used. Software for drawing diagrams as wellExcel 2007 underWindows was used

3. Results and Discussion

3-1- Characteristics of date puree

Date fruit has a high nutritional value and contains 25% sucrose, 50% glucose, pectin and water, although the amount of water in it varies depending on the type of fruit and its stage of ripening [33]. the amount ofpH The consumption of date puree was measured as 5.903±0.048, which is with the valuespH Measured for other date cultivars, including Mozafati (5.65), Shamsai (5.61) and Krut (5.71) dates, which were evaluated during a research, were consistent [34]. According to Table 2, the date puree used in this research has relatively low moisture and high dry matter (894.894±0.010%), which due to the high content of sugar compounds and other compounds found in dates such as protein, Fat, minerals, and fiber make sense. Maqsoodi (2014) reported the amount of fresh date ash equal to 1.44% [33] andThe pool et al. (2011) during a research stated the amount of date fruit ash in the range of 0.1 to 1.9% [16] which is in agreement with the amount of ash measured for date puree in this research (1.766±0.02%). has it.

Table 2 Physicochemical properties of date puree

	pH	Total ash (%)	Moisture (%)	Dry matter (%)
Date puree	5.903±0.048	1.766±0.020	10.106±0.010	89.894±0.010

The data are the mean of 3 replications (Mean± SD).

3-1- Features Physicochemical

according to diagram 2-A, investigate the level ofpH gel mixtures (before gel closure) in this research showed that the mutual effects of agar and gelatin hydrocolloids onpH The samples were not significant (0.05<p). The reason is that because the amountpH Agar hydrocolloid (10% aqueous solution) is equal to 6.8 and for gelatin typeB (which is used in this research) is equal to 5 to 7.5[35], therefore due to relative similaritypH In these two hydrocolloids, replacing gelatin with agar has not made any significant changes in the samples. While the comparison between the control sample and the sampleA0G100 whose difference is in the absence of date puree in the formulation of the control sample, showed that the amountpH The samples are significantly affected by the presence of date puree. So that in the control sample, which is free of date puree and formulated only on the basis of gelatin, the quantitypH It is equal to 4.896±0.035, but with the addition of date pureepH It was measured as 5.903±0.048 (Table 2).pH All samples show a significant increase, which is logical.

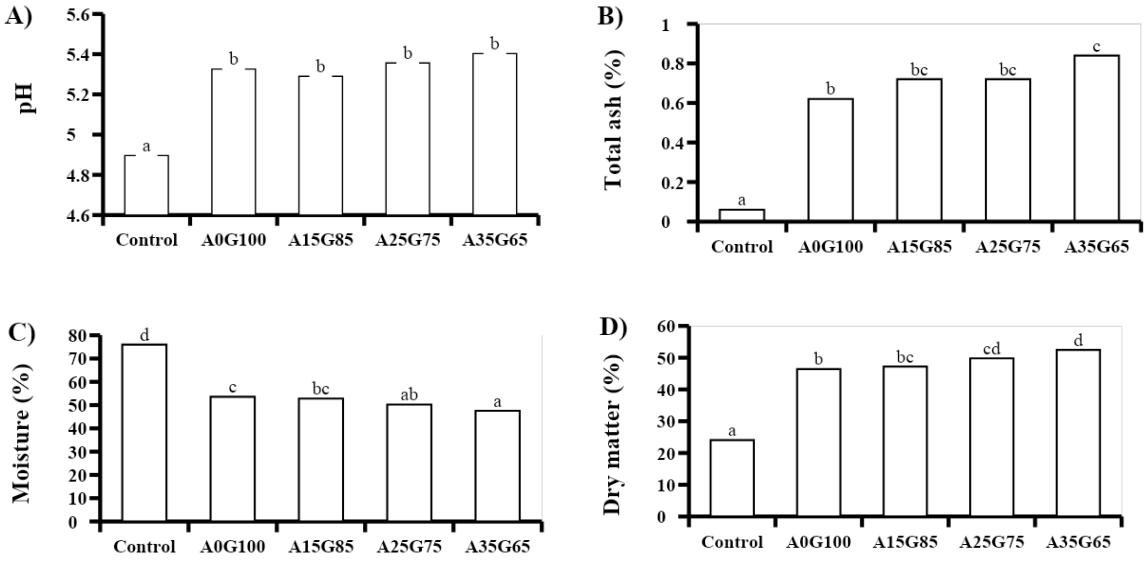
[9] -Firmness
[10]- Rubberiness
[11] -Surface moisture

Different samples of jelly candy and the control sample showed a significant difference with each other in terms of the amount of total ash (0.05p<) (Chart 2-B) and by adding date puree and increasing the amount of agar hydrocolloid, the amount of ash in the samples has increased so that the most ash in the sampleA35G65 And the lowest ash of the control sample is 0.846±0.102% and 0.060±0.020%, respectively. Since the amount of total ash of date puree consumed in this research was measured as 1.766±0.020% (Table 2), therefore replacing water with date puree in the sampleA0G100 Compared to the control sample, it has led to a significant increase in the amount of ash. On the other hand, increasing the replacement of gelatin with agar has also caused a significant increase in the amount of total ash, which is due to the high amount of agar ash (about 6%) compared to gelatin ash.B used in this research is (2-0.5%) [35]. Research resultsMr et al. (2015) onProduction of fruit bar snacks using two varieties of datesNabat Ali AndSukkari, indicated that there was no significant difference between the samples in terms of the amount of total ash]36[.

Examining the effect of adding date puree to the formulation of the samples showed that the moisture content of the samples decreases in comparison with the control sample (without date puree), which of course is due to the low moisture content of the consumed date puree (Table 2). On the other hand, it can be seen (Figure 2-C) that by increasing the content of agar and reducing the amount of gelatin in the samples, the moisture content of the sample is reduced and there is a statistically significant difference at the 95% confidence level (0.05p<). Since gelatin has a protein structure and water absorption can be considered the most important physical property of proteins, which is done through the connection of amine or carboxyl groups and the creation of hydrogen bonds.[21], therefore, by reducing the amount of gelatin, the ability to absorb water and moisture is also reduced in the samples so that the lowest amount of moisture in the sampleA35G65 It was measured with a value equal to 47.533±2.269%. In general, it can be said that agar does not have the ability to retain and absorb water during drying, and increasing its amount could not prevent water from leaving the candies tissue. Khazai Pool et al. (2013) reported that the moisture content of kiwi pastille samples was significantly affected by guar, while the effect of agar alone and the mutual effects of these hydrocolloids on moisture content were not significant, and these researchers attributed it to the hydrogel nature and high absorption. Water was expressed by guar gum [15]. In 2013, after investigating the effect of gum arabic on the moisture content of pastille soy milk samples, Maggi Kia et al. stated that the presence of gum arabic prevents excess water from leaving the tissue of the samples during drying, thus increasing the amount of moisture retention in the pastille samples. finds [37]. A similar trend was observed by Khalilian and colleagues in 2013 regarding the addition of xanthan gum in the formulation of cantaloupe paste [11]. similar to the results of the humidity section and according to the diagram in Figure 2-D, there is a significant difference between all the samples in terms of the amount of dry matter (0.05p<), in such a way that the increase in the replacement ratio of agar hydrocolloid causes an increase in the amount of total solids in the samples compared to the sampleA0G100 (free from agar). On the other hand, since the date puree used in this research has a high dry matter equivalent to 99.695±0.010% (Table 2), as a result, the addition of date puree to the composition of jelly candy samples increases the amount

Their dry matter is dry compared to the control (without date puree).

according to diagram 2-AND, although increasing the replacement levels of agar hydrocolloid caused the samples to have less water activity, but could not create a significant difference between them (0.05)<p). On the other hand, the addition of date puree in the formulation did not have a significant effect on water activity compared to the control sample. Since both agar and gelatin change into a helical network after absorbing water, which then condenses and water molecules are trapped in this network [38], therefore, different levels of replacing gelatin with agar have a significant effect on the activity level. The samples did not have water, of course, the decreasing trend observed in the water activity with the decreasing trend observed in the moisture content (Figure 2-C) shows a good match [21]. Examining the effect of adding date puree on the amount of water activity of the candy samples showed that there is no significant difference between these samples and the control sample (without date puree), which of course is due to the presence of various components of dates such as fibers, fibers, etc., which can dissolve in water. or does not absorb water and therefore cannot directly affect the level of water activity [26]. Shahidi et al reached similar results during their research (2013); They announced that increasing the concentration of pectin hydrocolloids up to a concentration of 1.5% and starch up to a concentration of 2% has a reducing effect on the water activity of apple paste samples, which is not significant.]20[. Khalilian et al. also in 2013, after examining the water activity level of cantaloupe pastille samples, stated that with the increase in pectin concentration, the water activity level of the samples decreased, while With the presence of xanthan gum, the amount of water activity of the samples increased significantly, which is due to the lack of firm connection of water molecules in the structure of xanthan gum due to the hydration of its side chains.]11[.



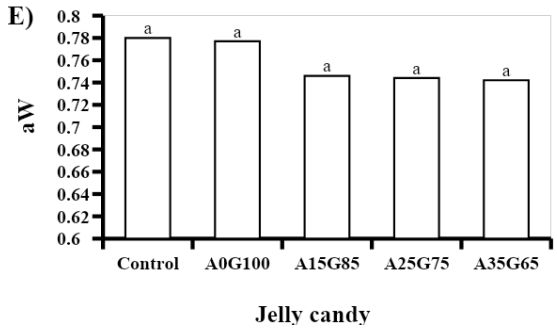


Fig 2 Physicochemical properties of jelly candy, A) pH (before molding), B) total ash, C) moisture, D) dry matter, E) a_{IN} (The letters A and G representing, respectively, agar and gelatin and also the numbers are showing the percentage of substitution)(Means with different letters differ significantly in $p<0.05$).

Color index*L** It is a clear indicator in food and its values vary between 0 and 100. According to the results of Table 3, a significant difference was observed between the different samples of jelly candies prepared with dates in terms of this color index (0.05>p). According to the obtained results, it was determined that the effect of adding date puree on*L** It is very meaningful and causesThis index dropped significantly which itself indicates a clear decrease and increasedark color In the samples containing date puree. Since the aqueous solution of agar is more transparent than the aqueous solution of gelatin, therefore, the increasing trend observed in the samples in which the replacement of gelatin with agar increased over the amount*L** has also been added, it is acceptable and consistent with the results of other researchers. During a research in 2012, Rahimi Dogahi and colleagues announced the effect of hydrocolloidsCMC and agar on the indicator*L** The tomato pastille samples were significant and due to the increase of different levels of these hydrocolloids, the brightness of the pastille samples increased.[14]. The results of the research conducted by Sadeghi et al. (2013) on almond milk-based pastille indicated that between the color index*L** and pectin and agar concentrations in paste samples, there is a positive and direct correlation; So that with increasing concentrations of pectin and agar, the amount of color index*L** increased in the samples [31]. Indicator*b**It is related to yellow-blue color [14], which was observed by adding date puree to the samples, that its amount decreases drastically, so that the sampleA0G100 (free from agar) the lowest amount*b** (7.730±1.107) (Table 3). Due to the fact that carotenoids, anthocyanins, procyanidins and flavonoids are among the phytochemical compounds in date fruit that create the blue-purple and red color spectrum [16], therefore, adding date puree to the samples reduces the amount of yellowness. which itself comes from gelatin). On the other hand, it was observed that by increasing the substitution of agar instead of gelatin, on the value*b** It was added that it is consistent with the results of other researchers. Sadeghi et al. in 2012 after examining the trend of average changes*b** Almond pastille samples in different levels of agar and pectin, declared that the color index value*b** In all agar levels, there was a decreasing trend with increasing pectin concentration (decreasing agar concentration) [31]. In 2012, Rahimi Dogahi and colleagues stated the effect of agar on color index*b** Pastille tomato samples were not significant, whileCMC By increasing the water activity and decreasing the amount of beta-carotene degradation, it caused a significant increase in the yellow color index in the samples [14]. The results showed that the addition of date puree has a positive role in increasing the color value*a** There are gels in the candy samples, so that in the samples containing agar, the amount*a** More than

sampleA0G100, that is, the sample that only contains gelatin, and different treatments have a significant difference with each other in terms of index*a** (red-green) showed (0.05>p). The lowest amount*a** It was observed in the control sample (without date puree) and by adding date puree to the formulation, there was a significant increase in the redness of the samples, but as it was said in the previous section, the presence of different pigments that are present in dates increases the incidence of red color. It justifies in examples. Apart from the sampleA0G100, other samples that contained different amounts of agar and gelatin showed a significant difference with each other. Sadeghi et al. announced in 2012 that the amount of color index*a** By increasing the concentration of pectin and agar hydrocolloids in almond milk paste, it decreased [31]. In 2013, Khazaei Pool and colleagues investigated the effect of two hydrocolloids, agar and guar, on color index.*a** In the pastille formulation, they discussed and announced that with the increase in the concentration of these two hydrocolloids, the amount of color value*a** decreases [15].

Table 3 Color indices of jelly candies

Jelly candy	*L**	*b**	*a**
Control	42.890±2.113[d]	20.576±1.441[d]	0.083±0.041[a]
A0G100	26.936±0.290[a]	7.730±1.107[a]	3.770±0.345[b]
A15G85	36.403±0.295[b]	14.523±0.465[b]	5.293±0.391[c]
A25G75	39.050±1.001[c]	15.213±0.427[bc]	4.776±0.376[c]
A35G65	40.220±0.640[c]	16.510±0.363[c]	4.680±0.406[c]

The data are the mean of 3 replications (Mean± SD) and means with different letters are significantly different (p<0.05). The letters A and G representing, respectively, agar and gelatin and also the numbers are showing the percentage of substitution.

2-3- Histological results

The texture and physical properties of food affect its taste; Because the texture can to some extent control the amount and speed that the flavoring substance reaches the taste buds.[39]. Jelly candy is a viscoplastic substance with a specific texture that is related to its hardness, elasticity and malleability. Therefore, it is very important to use an appropriate method to determine the mechanical and rheological properties of such products [40]. Tissue profile analysis machine test orTPA As the most popular test method, it has been used for many years as a suitable method for measuring the textural characteristics of food [41]. In imitation tests such as tissue profile analysis, an attempt is made to simulate the mechanical movements of biting or chewing. This method is due to the ability to measure multiple tissue parameters that have a high correlation with sensory data; It has many fans [11]. stickiness[12] It is the work required to overcome the force of gravity between the surface of the food and the surface of other materials that are in contact with the food [42]. according to diagram 3-A By increasing the amount of agar hydrocolloid content instead of gelatin and also adding date puree (compared to the control), the amount of adhesion of the samples increased significantly and an upward trend is observed, so that the highest and the lowest amount of tissue adhesion is respectively in the samplesA35G65 and the control sample with values of 2.043±0.386N.S and 0.278±0.393N.S seen. The reason for the occurrence of stickiness in the tissue after adding dates to the formulation, as well as increasing the replacement of gelatin with agar, can be attributed to the sticky nature of date puree and the aqueous solution of agar, which showed more stickiness compared to the

[12]- Adhesiveness

aqueous solution of gelatin. These results are in line with the results of Khazaei Pool et al.'s research in 2013, who reported that the effect of agar on the adhesion of pastille kiwi samples was significant [15]. By definition, hardness[13] The resistance of food to the application of pressure force has been used [42]. One of the characteristics of agar hydrocolloid is to create a strong network in gel products [43], but despite the expectation, replacing gelatin with agar did not have a significant effect on the hardness of the sample tissue (0.05).<P) (Chart 3-B) which the probable cause was the effect of two strains of gelatin gel and agar gel on each other, which almost reduced the strength of the agar gel to some extent and the hardness was similar to the sample without agar.A0G100) It can be seen. On the other hand, the addition of date puree did not have a negative effect on texture hardness, so that no significant difference was observed between the control sample and the samples containing date puree. Armin's AndGalatians They investigated the effect of carob gum on the hardness and strength of agar gel and showed that with increasing percentage of agar, the amount of resistance and hardness of the gel increases, while with the increase of replacement of carob gum, the strength and hardness of the final gel decreased [44].Jain-Rainaet al. (2011) also stated in relation to the mixture of agar gels with other hydrocolloids that the strength of the gel increased with the increase in the percentage of agar [45]. Khazaei-Poul et al. (2013) also reported that the effect of agar on the texture hardness of pastille kiwi samples was significant, while the effect of guar alone and the opposite effects of agar and guar were not significant [15].In 2012, Rahimi Dogahi et al stated that with the increase in the concentration of agar in the formulation of tomato paste, the strength of the final gel increased.]14[.

The amount of force that causes the material to break, fragility[14] It has a name that is also mentioned by the name of crispy in some sources]42[The degree of brittleness measured by the deviceTPA, represents the amount of force that caused brittleness at the micromolecular level. The results of the evaluation of the brittleness characteristic, as well as the hardness characteristic, indicated that due to the replacement of different levels of gelatin hydrocolloid with agar and the addition of date puree to the sample composition, there was no significant change between the different formulas in terms of this characteristic (Figure 3-C). The highest amount of brittleness in the sampleA35G65 It was observed that the reason is the brittleness of the agar gel[15] And it is interesting to note that the addition of date puree has led to a decrease in brittleness in the samples compared to the control sample (without date puree), although its effect was not significant at the 95% confidence level (0.05).<p). Abdali and Motamedzadegan reported that the mechanical strength and resistance of fat-free molded yogurt samples increases with the increase of gelatin concentration due to the high amount of protein in the samples, which increases the formation of cross-links [46]. The return rate of the deformed material to its original shape after the removal of the deforming force is so-called phenrite[15] They say that in the curve it is equivalent to the distance that the food item recovers its original height over time [14]. according to diagram 3-DThere is no significant difference between the control sample that does not contain date puree and the different formulations that contain different amounts of agar and gelatin hydrocolloids in terms of phenrite or elasticity

[13]- Hardness

[14]- Fracturability

[15]-Springiness

(0.05).<p). Comparison between the control sample (without date puree) and the sampleA0G100, shows that despite the non-significance of the effect of adding date puree on the properties of fenrite texture, the reduction of phenrite with the addition of date puree to the formulation is well evident. On the other hand, due to the complex and branched structure of agaropectin in agar, the agar gel has a low elastic state (phenrite) [15] and its presence caused a decrease in the amount of phenrite in the samples in such a way that the lowest amount of phenrite in the sampleA35G65 It was found equal to 0.876±0.042. These results are consistent with the results of Khazaei Pool et al.'s research (2013) who reported that in fixed concentrations of guar, with the increase of agar in the Kiwi pastille formulation, the elasticity decreased, while in fixed concentrations of agar, the increase of guar led to an increasing trend. In the amount of elasticity and springiness of the pastille samples [15]. Rahimi Dogahi et al. (2012) also stated that agar has a negative effect on the elasticity and phenrity of tomato paste samples [14]. Also, Shahidi et al.'s results regarding the effect of starch and guar on the elasticity of carrot pastille samples were based on the fact that with the increase in guar concentration due to its linear structure, the springiness of the texture of the pastille samples increased, while with the increase in starch concentration due to the branched structure And its inability to form a springy hard gel reduced the elasticity of the tissue [13].

According to the definition of rope[16] The texture is related to the amount of stretching of the food before it is separated from the pressing plate (upper jaw) of the texture measuring device]47[. according to diagram 3-AND, there is a significant difference between the control sample and different formulas in terms of the texture characteristic of ropeness at the 95% confidence level.(05/0p<). The results showed that with the increase in the percentage of agar hydrocolloid in the samples, the amount of stringiness of the tissue increased, but this increase was not significant, while the addition of date puree to the formulation significantly increased this feature, which of course indicates an increase in the amount of stretching in the samples. The form of existence is date puree.

[16]- Stringiness

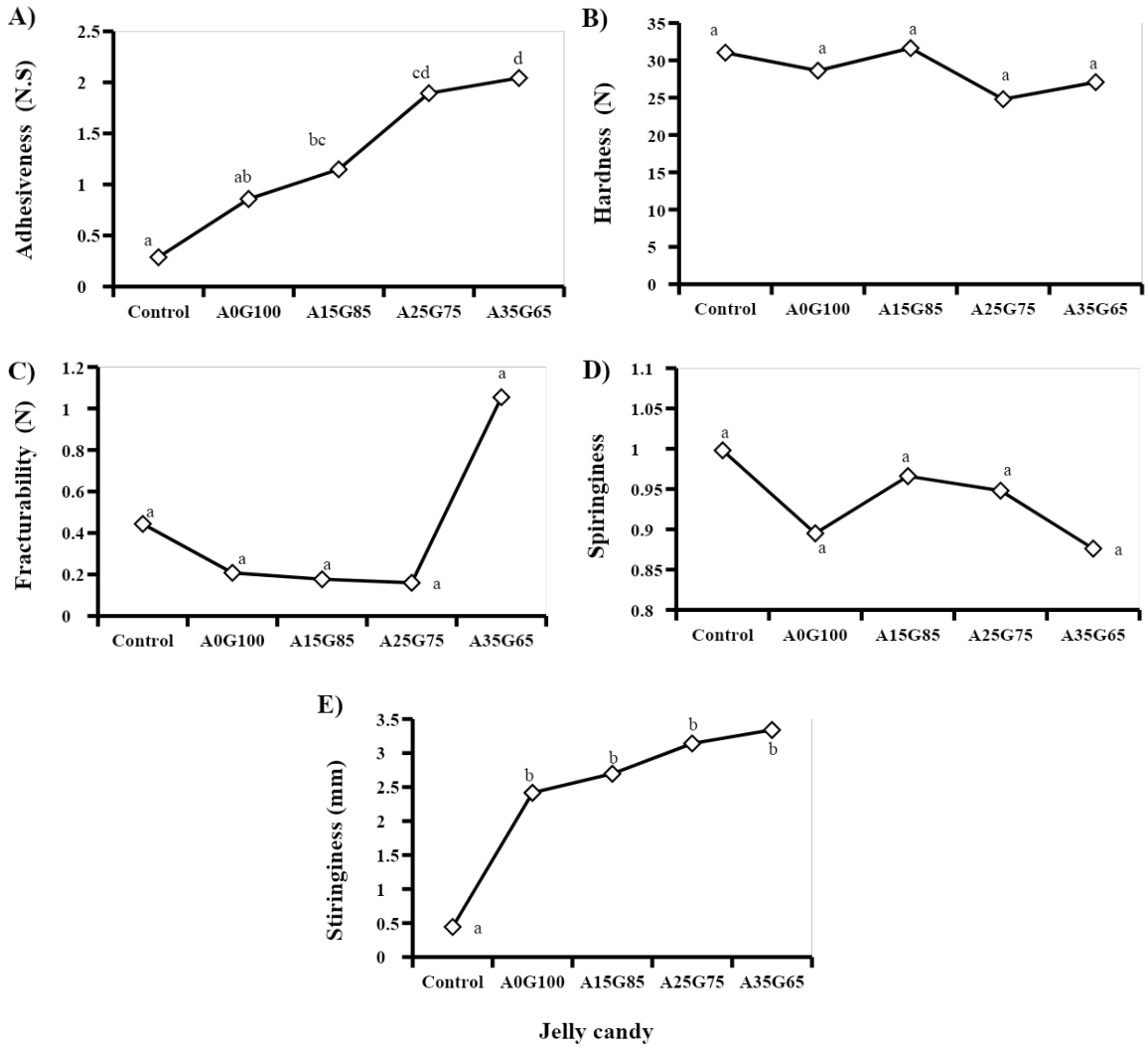


Fig 3 Texture properties of jelly candy, A) Adhesiveness, B) Hardness, C) Fracturability, D) Springiness, E) Stringiness (The letters A and G representing, respectively, agar and gelatin and also the numbers are showing the percentage of substitution)(Means with different letters differ significantly in $p<0.05$).

3-3- Sensory evaluation results

Sensory evaluation provides the opportunity to obtain a complete breakdown of textural characteristics perceptible by human senses from food. When food is chewed in the mouth, processes such as shape change, flow, crushing, moistening with saliva, etc. take place. All these changes are recorded by humans with high sensitivity, but most of them cannot be measured by devices. Almost no device has been built with the sensitivity, complexity, range of mechanical movements and delicacy like the mouth, which can react quickly in response to the received sensation.]48[. The results of the sensory evaluation of 10 traits investigated in this research are given in Table 4. Examining the characteristics of the appearance of the samples during sensory evaluation showed that there is a significant difference between the samples at the 95% confidence level (0.05>p) ؛So that increasing the percentage of agar replacement has a negative effect on the shape and moldability of

jelly candy samples. It seems that this problem is caused by the presence of the hydrophobic part of agar, i.e. agaropectin, which causes the solubility of agar to decrease compared to gelatin, and as a result, the agar gel does not have a uniform texture after it is formed, and in addition, it is difficult to mix it with other components of the formulation. Makes. Therefore, the appearance of the prepared samples containing different levels of agar after leaving the mold compared to the sampleA0G100 (lack of agar), has less uniformity, while agar hydrocolloid due to its sticky nature has very little moldability, which ultimately caused an inappropriate appearance in the samples from the point of view of sensory evaluators. The results of Shahidi et al.'s research (2013) on apple pastille showed that the arrangement and uniformity of the surface (texture and shape) as well as acceptance in terms of the appearance characteristics of the surface in different pastille formulas did not differ significantly from each other.[20]. On the other hand, the replacement and the amount of hydrocolloid content of agar could not have significant effects (95% confidence level) on different samples in terms of color index, and the sensory evaluators did not find a difference between the samples without dates or agar and other samples.By increasing the percentage of agar hydrocolloid in the samples, the score related to the desired color decreased, but this difference was not significant according to sensory evaluators.05/0p>). The findings of other studies also indicate that the addition of hydrocolloids such as agar, pectin, gellan and carrageenan in different proportions reduces the color of the solution.]49[And according to the transparent appearance of the samples available in the market, which has caused the transparency index to be one of the expected features of the consumers of this product, it seems that this decrease in transparency has led to a decrease in the desirability of color in the eyes of sensory evaluators.The results of Khazai Pool et al.'s research showed that agar and guar hydrocolloids and their mutual effects did not have a significant effect on the color intensity of pastille kiwi samples.]15[. The results of Sadeghi et al.'s research (2012) also showed that betweenThe degree of color desirability and finally the final acceptance of the samples There is a high correlation, they stated that by increasing the brightness of the production samples of almond paste, the level of color desirability has increased, which itself has been effective on the final selection of the formula in terms of sensory analysis.]31[. According to Table 4, the jelly candy samples had a significant difference from each other in terms of surface moisture score during sensory evaluation at the 95% confidence level (0.05p<) and bReplacing agar hydrocolloid instead of gelatin, the surface moisture score has decreased significantly (05/0p<), as the exampleA0G100 which does not contain agar hydrocolloid, received the highest score related to the property of surface moisture. Therefore, as mentioned in the previous sections, the reason for the increase in the surface moisture of the samples is the higher water absorption ability of gelatin compared to agar hydrocolloid, which seems to have resulted in a more favorable mouthfeel for the evaluators. This result is also in line with the results of Shahidi et al. (2013) who reported that regarding the acceptance of sensory and textural characteristics of apple puree pastille samples, surface moisture along with hardness, chewability and rubberiness had the greatest effect on their acceptance.]20[. Different samples differed from each other in terms of taste characteristics So that by substituting agar hydrocolloid instead of gelatin, the taste perception of pastille date samples decreased significantly (0.05p<) and the highest degree of taste desirability according to sensory evaluators to the sample without agar hydrocolloid, that isA0G100 with amount887/0±20/4 was awarded Perception of taste in the brain is the result of the combination of two senses of smell and taste; Therefore, taste perception is divided into two groups of compounds, volatile compounds that are perceived through the olfactory epithelium (aroma) and non-volatile compounds that are sensed through taste buds on the tongue

(taste).]50[. Researchers also believe that understanding the intensity of flavor and the speed of release of flavoring substances in food depends on the type of hydrocolloid used and the texture of the final product.]50-51[. melting At Mouth one ofPhysical characteristics It is gelatin that causes its melting to occur at a temperature lower than the physiological temperature of the body (37 degrees Celsius).]49[, despite the fact that the gel obtained from agar has high thermal resistance and can withstand temperatures of 80 to 90 degrees Celsius.]15 ،21[؛ Therefore, it seems that the mixing process of agar gel with oral saliva is slower than gelatin gel, and in this way, the release The flavor is slower and less intense. In this regard, The results of this research with the research resultsBoland et al. (2006) agreed that regarding the release of aromatic compounds after swallowing, it showed that the release values were significantly higher in pectin gel than in gelatin gel and this could be due to the lower melting temperature in pectin gel compared to gelatin.]52[. Beak et al. (1999) also stated that soft gelatin gels have the ability to release more aromatic compounds than hard gels [53]. In another study, Shahidi et al. (2013) stated that the apple pastille formulation containing the highest concentration of hydrocolloids (1.5% by weight of gelatin and 4% by weight of starch) had the lowest taste and aroma scores from the evaluators' point of view due to the high hardness of the texture. [20].The results of sensory evaluation showed that the replacement of agar hydrocolloid with gelatin did not have a significant effect on the sweetness of the samples.(05/0<p)، So that according to the evaluators, all the samples of jelly candy were equally sweet and received similar scores (Table 4). In this regard, taking into account that the amount and ratio of all sweeteners (sugar, glucose syrup, glucose powder) and date puree are constant and unchanged in the samples, and also considering the main feature of agar and gelatin hydrocolloids, which is the formation of a gel. ; It seems that agar and gelatin gels played an equal role in spreading the sweet taste, and different levels of substitution did not increase or decrease the perception of sweet taste by the sensory evaluators. In this regardHanson et al. (2001) reported that because of their high viscosity, gelled foods are an obstacle to the diffusion and release of flavor compounds, which can be attributed to the different interactions between gelling agents and flavoring substances in the texture of the food.]54[. Hollowood et al. (2002) stated that the inputs of taste and texture interact, in other words, when the evaluator understands the firmness of the texture, he neglects to understand the sweetness and aroma of fruits [55].

Table 4 Sensory properties of jelly candy

Jelly candy	Apparent shape	Color	Surface moisture	Flavor	Sweetness	Hardness	Rubberiness	Chewiness	Adhesiveness	Overall acceptance
A0G100	4.40±0.93^{a}	4.00±1.01^{a}	4.10±0.88^{a}	4.20±0.88^{a}	3.77±1.04^{a}	4.13±0.82^{a}	4.20±0.85^{a}	4.13±0.77^{a}	4.13±1.04^{a}	4.23±0.77^{a}
A15G85	3.73±0.98^{b}	3.53±1.14^{a}	3.50±1.17^{b}	3.37±0.96^{b}	3.23±1.10^{a}	3.50±1.07^{b}	3.60±0.93^{b}	3.37±1.03^{b}	3.37±0.94^{a}	3.63±0.96^{b}
A25G75	3.60±1.04^{b}	3.40±1.13^{a}	3.40±1.04^{b}	3.20±1.09^{b}	3.17±1.20^{a}	3.37±1.19^{b}	3.43±1.13^{b}	3.30±1.18^{b}	3.40±1.33^{a}	3.37±1.13^{b}
A35G65	3.63±1.03^{b}	3.50±1.22^{a}	3.33±1.19^{b}	3.30±1.18^{b}	3.10±1.03^{a}	3.20±1.27^{b}	3.17±1.26^{b}	3.30±1.20^{b}	3.43±1.22^{a}	3.37±1.9^{b}

The data are the mean of 3 replications (Mean± SD) and means with different letters are significantly different (P<0.05). The letters A and G representing, respectively, agar and gelatin and also the numbers are showing the percentage of substitution.

Substituting agar hydrocolloid instead of gelatin has a negative effect on the firmness characteristics of the samples, so that from the point of view of sensory evaluators, due to the increase in the replacement levels of agar hydrocolloid from 0 to 35%, it caused a significant decrease in the desirability of the gel candy samples in terms of firmness characteristics. And the downward trend is well visible andSensory evaluators between samplesA0G100 (without agar) and other prepared samples showed a significant difference in terms of this feature(05/0p<)but the other samples did not differ from each other in terms of texture stiffness. According to the results of the histometric test section, there was no significant difference between the treatments containing different levels of replacing agar with gelatin in terms of hardness characteristics; Therefore, it can be concluded that in terms of the stiffness and hardness of the tissue of the samples, a good correlation was obtained between the sensory parameters and the data obtained from the tissue analysis using the device method.The results of Abbasi et al.'s research (2013) in relation to frankincense pastilles indicated that replacing Persian gum instead of gelatin in pastille samples causes a significant difference in the textural characteristics of samples containing the highest percentage of Persian gum compared to samples containing 100% gelatin. showed and was considered unfavorable during the evaluation[32]. Shahidi et al. (2013) reported that the sensory characteristic of the hardness of carrot pastille samples had the greatest effect on increasing their acceptance by evaluators [13]. The results of the research conducted by Shahidi et al. (2013) on apple pastille showed that the concentration of 1.5% gelatin compared to all concentrations of starch caused a significant increase in the hardness of apple pastille samples [20]. According to Table 4,Replacing agar hydrocolloid with gelatin has had a significant effect on the rubber characteristics of the samples(05/0p<). Agar creates a solid gel network that is fragile and less elastic]15[And this is completely consistent with the results obtained for the jelly candy samples, so that according to the sensory evaluators, the highest score of the rubber attribute is given to the sample containing 100% gelatin.A0G100) and the samples containing different levels of agar substitution had less sensory desirability.The results of the research conducted by Khazai Pool et al. (2013) indicated that the effect of agar and guar on tissue elasticity is significant; As with the increase of agar, the brittleness and crispness of the samples increases]15[. According to the definition of chewability, it is the time required to chew the material at a constant speed until it is ready to be swallowed]12[. According to the results of the analysis of variance, sensory evaluators found a significant difference between samples without agar and samples containing different levels of agar for the chewability of the samples, as well as the rubbery characteristic.(05/0p<), so that the highest score of this characteristic to the sample containing 100% gelatin with the amount4.13±0.776 was allocated; Therefore, it is thought that with the increase in the amount of agar hydrocolloid replacement in the samples, the chewing ability decreased, which is an unfavorable feature in the eyes of the evaluators. The results of Khazai Pool et al. (2013) showed that the effect of agar and guar on the chewability of pastille kiwi samples was significant and positive, but the mutual effects of these hydrocolloids were not significant.[15]. Shahidi et al. (2013) stated that the apple pastille formulation containing the highest levels of hydrocolloids used (1.5% gelatin and 4% starch) had the highest score in terms of chewability by evaluators [20].Khalilian et al. (2013) and

Shahidi et al. (2014) achieved similar results in this field. They reported that the attribute of chewability, like other sensory attributes such as hardness, consistency and rubberiness, has the greatest effect on increasing the acceptance rate of samples. They had cantaloupe pastille and carrot pastille[11, 13]. On the other hand, replacing agar hydrocolloid instead of gelatin and also increasing the replacement levels did not have a significant effect on the viscous properties of the samples (0.05).<p), although there is a downward trend in it. In this regard, it seems that the stickiness of the samples is due to the presence of the same amount of date puree in their composition, which has a sticky nature, and in this sense, it has created the same amount of stickiness in all the samples. In 2013, Khazai Pol et al. stated that with increasing amount of agar, the viscosity of kiwi pastille samples decreased, which is not consistent with the results of this research [15]. Abbasi et al. (2010) stated that in terms of the sticky property, it was thought that due to the stickiness of the Persian gum solution, the addition of this gum would increase the sticky property, but the results of the sensory evaluation showed that the average score of this property was statistically significantly different in the level 95% do not have [32]. Shahidi et al. reported in 2013 that high values of the stickiness of carrot pastille samples lead to a negative effect on the acceptance of samples by evaluators [13].According to table 4, the sensory evaluators in the final stage after measuring all the characteristics of the jelly candy samples, including appearance, desirable color, surface moisture, taste, sweetness, firmness, rubberiness, chewability and stickiness, gave the highest overall acceptance score to the sample. Contains 100% gelatin ieA0G100 Assigned and examplesA15G85 ،A25G75 AndA35G65 obtained the following points from the evaluators respectively, this shows that in the eyes of the evaluators, agar hydrocolloid is not competitive with gelatin in the preparation of candy gels, the main reason of which can be due to the consumption of commercial samples available in the market for a long time by consumers and Accepting the characteristics of gelatin as a gelling hydrocolloid is desirable in the preparation of candy gels, which was probably effective in measuring the samples of this research. The results of Sadeghi et al.'s research (2013) also showed that the amount of agar in the formulation of almond pastille had a significant and negative effect on the general acceptance process of the samples.]31[. The results of Khazai Pool et al.'s research (2013) indicated that the effect of agar and guar as well as their mutual effect on the general acceptance of kiwi pastille samples was not significant.]15[. After examining sensory data, Rezaei et al. (2013) stated that there is a high correlation between taste acceptance and overall acceptance of pastille plum samples.]12[. The results of Shahidi et al. (2013) indicated that the most important textural characteristics affecting the overall acceptance of carrot pastille samples were hardness, consistency and chewability, so that increasing the values related to these characteristics increased the overall acceptance score of the samples.131[. Khalilian et al. reported that texture and taste characteristics had a greater impact on the overall acceptance of cantaloupe paste than the appearance characteristics of the samples.]11[.

4 - Conclusion

The use of natural compounds such as fruits or their derivatives in the formulation of food products is a challenge that has long attracted the attention of many researchers. Dates are considered one of the most important agricultural products of our country, Iran, which has a very high potential in preparing nutritious and innovative food products; Therefore, in the present research ofWaste dates were used in the formulation of a kind of nutritious jelly candy along with the replacement of part of gelatin with agar gum in the formulation of the product. The nutritious jelly candy prepared in this research has acceptable physicochemical, textural and sensory characteristics, butSubstituting agar hydrocolloid instead of gelatin caused a decrease in the quality characteristics of the samples. In general, it can be concluded that candy gels formulated with date puree and gelatin both from a technological point of view and from the point of view of consumers, have a significant advantage and can be produced and marketed on a mass scale after conducting relevant economic studies.

5- Resources

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سایت مجله: www.fsct.modares.ac.ir

مقاله علمی_پژوهشی

استفاده از خرمای ضایعاتی در تهیه نوعی آب‌نبات ژله‌ای و بررسی ویژگی‌های کیفی و حسی آن

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اطلاعات مقاله

تاریخ های مقاله :

تاریخ دریافت: ۱۴۰۰/۳/۱۲

تاریخ پذیرش: ۱۴۰۱/۱۰/۱۰

کلمات کلیدی:

خرمای ضایعاتی،

آگار،

آب‌نبات ژله‌ای،

غذای فراسودمند

DOI: 10.22034/FSCT.20.139.14

DOR:20.1001.1.20088787.1402.20.139.2.6

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چکیده

امروزه افزایش تقاضا برای غذاهای سلامتی‌بخش، سبب توجه روز افزون به کاربرد ترکیبات طبیعی نظیر انواع میوه‌ها در فرمولاسیون محصولات غذایی گشته است. در این پژوهش از خرمای ضایعاتی (درجه دو) در فرمولاسیون نوعی آب‌نبات ژله‌ای مغذی (تا ۳۰ درصد) همراه با جایگزینی بخشی از ژلاتین با صمغ آگار (۰، ۱۵، ۲۵، و ۳۵ درصد) استفاده شد. سپس نمونه‌ها از نظر ویژگی‌های فیزیکوشیمیایی (رطوبت، ماده خشک، فعالیت آبی، خاکستر کل و شاخص‌های رنگی)، بافتی (سختی، چسبندگی، فنریت، طنابی بودن و شکنندگی) و چشایی مورد ارزیابی قرار گرفته و از آزمون تحلیل واریانس یک‌طرفه در سطح اطمینان ۹۵ درصد جهت آنالیز آماری استفاده شد. نتایج نشان دادند که با افزودن پوره خرما به فرمولاسیون آب نبات ژله‌ای، کاهش معنی‌داری در محتوای رطوبت، L^* و b^* مشاهده گردید ($p<۰/۰۵$) در حالی که میزان خاکستر کل، a^* و هم‌چنین ویژگی های بافتی چسبندگی و طنابی بودن افزایش یافتند ($p<۰/۰۵$). قابل توجه است که افزودن پوره خرما، تاثیر معنی‌داری روی فعالیت آبی و هم‌چنین ویژگی‌های بافتی سختی، فنریت و شکنندگی نداشته است ($p>۰/۰۵$). جایگزینی ژلاتین با آگار (تا ۳۵٪) در نمونه‌ها، سبب کاهش محتوای رطوبت و افزایش میزان خاکستر کل، شاخص‌های رنگی و ویژگی‌های بافتی چسبندگی در سطح اطمینان ۹۵٪ گردید ($p<۰/۰۵$)، در حالی که اثر آن روی سایر ویژگی‌های بافتی و هم‌چنین فعالیت آبی معنی‌دار نبود ($p>۰/۰۵$). مطابق با نتایج ارزیابی چشایی، آب‌نبات ژله‌ای تهیه شده از ژلاتین (فاقد آگار)، به عنوان بهترین نمونه شناخته شد که البته ویژگی‌های فیزیکوشیمیایی و بافتی مناسبی را نیز دارا بود.