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المجلة العراقية لبحوث السوق وحماية المستهلك

THE EFFECT OF ADDING KAPPA- CARRAGEENAN ON THE PHYSICOCHEMICAL AND SENSORY PROPERTIES OF PECTIN SWEET MADE FROM DATES.

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ABSTRACT

The aim of the research is to add kappa-carrageenan to pectin sweets instead of pectin and to know its effect on the physicochemical and biological properties, Contains pectin sweets of pectin represents the control treatment T1, while T2 50% of the pectin was replaced kappa-carrageenan and T3 have a total replacement of pectin with kappa-carrageenan and compare the results with the control treatment, The chemical composition of Zuhdi dates were 70.28%, 59.20%, 18.28%, 2.68%, 2.57%, and 0.47% for each of the total sugars, reducing sugars, protein، fats, ash and moisture (respectively).we did not notice significant differences in the pectin sweet manufactured for the treatments T1, T2, and T3 for total sugars 60.75%, 60.05%, 59.12%, protein (0.63, 0.52, 0.35 %, fat 0.37%, 0.36%, 0.38%, total ash 1.51%, 1.58%, 1.66%, pH (4.06, 4.14, 4.16) and total acidity amounted to 1.21%, 1.18%, 1.15% for dissolved solids 56%, 66%, 69% and the refractive index (1.4572 , 1.4570, 1.4576), there are significant differences T1, T2, and T3 for density with T3 superiority 1.333 g/ cm^3 compared to T1 and T2 amounted to (1.293,1.325) g/ cm^3, and also the viscosity was superior to T3 reached 5831 cp compared to T1 andT2 amounted to (5388,5440) cp as well as the turbidity reached the highest value of T3 (180) NTU compared to T1 and T2 It amounted to (160, 165) NTU, while the electrical conductivity was better for T3 treatment, which amounted to 1160 µs/ cm compared to T1 and T2 (680,980) µs/ cm. Sensory tests showed that there were significant differences for the pectin sweet in terms of taste, texture and general acceptance, while there were no significant differences in the values of appearance and color, and there was no growth of microorganisms (bacteria, fungi) in the pectin sweet.

Keyword: Pectin sweet ,kappa - carrageenan, Gelatin ,liquid sugar.

تأثير اضافة كابا- كاراجينان في الخصائص الفيزيوكيميائية والحسية للحلوى البكتينية المصنعة من التمور

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الخلاصة

الهدف من البحث اضافة كابا- كاراجينان للحلوى البكتينية بدل من البكتين ومعرفة تاثيره على الخصائص الفيزيوكيميائية والبيولوجية، اذ تحتوي الحلوى البكتينية على البكتين التي تمثل معاملة السيطرة T1 اما T2تم استبدال 50% من البكتين بكابا-كاراجينان وT3يكون فيه استبدال كلي للبكتين بكابا –كاراجينان ومقارنة النتائج بمعاملة السيطرة، ظهرت نتائج التركيب الكيميائي لتمر الزهدي 70.69%، 59.20%، 2.68%، 0.47%،2.57%، 18.28% لكل من

[*] **Research extracted from the doctoral thesis of the first researcher.**

السكريات الكلية والمختزلة والبروتين والدهون والرماد والرطوبة، لم نلاحظ فروق معنوية في الحلوى البكتينية للمعاملات T1وT2وT3 للسكريات الكلية 60.75 %،60.05%، 59.12% والبروتين 0.63%، 0.52%، 0.35% والدهون 0.37% ، 0.36% ، 0.38% والرماد الكلي 1.51 %، 1.58%، 1.66% والرقم الهيدروجيني 4.06، 4.14، 4.16 والحموضة الكلية بلغت 1.21%، 1.18 %، 1.15% وكذك لم نجد فروق معنوية في الحلوى البكتينية للمواد الصلبة الذائبة 65 % ،66 %، 69% ومعامل الانكسار 1.4570، 1.4572، 1.4576 وجود فروق معنوية للكثافة بتفوق T3 1.333 غم /سم^3 بالمقارنة مع T1وT2 بلغت 1.293، 1.325 غم /سم^3 واللزوجة تفوقت T3 بلغت 5831 سنتي بويز بالمقارنة T1 و T2 بلغت 5388، 5440 سنتي بويز وكذلك العكارةT3 بلغت اعلى قيمة 180 NTU بالمقارنة T1وT2 (160، 165) NTU والتوصيلة الكهربائية كانت افضل معاملة T3بلغت 1160 ملي سيمنز/سنتيمتر بالمقارنة T1 وT2 (680، 980) ملي سيمنز/سنتيمتر .أظهرت الاختبارات الحسية وجود فروق معنوية للحلوى البكتينية من حيث الطعم والملمس والقبول العام، بينما لم تكن هناك فروق ذات دلالة إحصائية في قيم المظهر واللون، ولم يكن هناك نمو للكائنات الحية الدقيقة (بكتريا، فطريات) في الحلوى البكتينية.

الكلمات المفتاحية: الحلوى البكتينية، كابا-كاراجينان، جلتنة، السكر السائل.

INTRODUCTION

To avoid the health risks resulting from the use of chemical additives, the idea of relying on natural sources was born .Especially the marine ones, so attention turned to the use of algae because it is one of the important alternatives for the processing of effective compounds such as proteins, sugars, and fats (**Hindi *et al.*, 2015**). one or more functions and multicellular algae can be seen with the naked eye, and differ from higher plants; Because they do not have true roots, stems or leaves, they are found in salt water and fresh water and are fast growing.

Algae contain a high percentage of polysaccharides, which is the main component of the algae cell walls. Marine polysaccharides include carrageenan, agar, alginate, and others. They are all known as phycocolloids, or hydrocolloids, or gums. They differ from each other in the nature of their sugar units. And the length of its chains and branching, and the most important thing that distinguishes it is its high content of fiber, and it consists mainly of high-molecular sugars that are stored in the walls of cells, as they are extracted and used as thickeners or gelatinizing polymers, and that eating them can help reduce the incidence of heart disease, diabetes and the risk of cancer. Widespread use in recent years, due to its important chemical properties and biological effects (**Aziz & Salman, 2011**). Nowadays, there is a tendency to use long-chain hydrocolloids such as cellulose, alginate, and starch in food packaging before frying them to be a barrier that prevents the absorption of fat and a barrier to oxygen and carbon dioxide (**Muhsen *et al.*, 2019**).

Kappa-carrageenans are linear, water-soluble polymers found in the cell wall of red algae consisting of repeating units of (β-D-galactose 4-sulphate) linkage with a ring (3,6-anhy drogalactose) linked together by glycosidic bonds α-(1,3) and β- (1,4) with one sulfur group per disaccharide repeat unit generally forms strong and solid gels with potassium salts but the gel becomes brittle with calcium salts (**Nassri & Mahmed, 2022)**

Carrageenan is a linear heterogeneous polysaccharide with a high molecular weight that contains half of the sulfate esters, which makes it have an ionic strength so that it forms gels in the presence of positive ions such as calcium and potassium. It is widely used in the food industry to give density and be gels and thickeners as in toothpaste. Recently, carrageenan has been widely used in other fields, such as the pharmaceutical industry. Carrageenan is used as an antiviral (antiviral, oxidative, and inflammatory) and reduces cholesterol in the blood and absorbs secretions. Transport systems based on carrageenan are effective in transporting the active substance of turmeric, which is curcumin, which contains compounds phenolic, and the low aqueous solubility of turmeric limits the possibility of taking it orally, so curcumin is coated with carrageenan, which is useful in delivering it to the small environments of tumors

and its association (**Al-Aubadi *et al.*, 2014**).There are six types of carrageenans depending on the sulfites groups and their association with the aldehyde sugar lactose. The first three of the carrageenans are important commercially, and the types of carrageenans differ in the degree of sulfur they contain: (K) Kappa, (ι) iota, (λ) lambda, mu, and nu and theta **(Hilal & Obaid, 2020**).

And that the expansion of the use of dates in food products works to increase the consumption of this food that is available locally by finding new and feasible channels in the disposal of dates, where the economic return for them will be better than it is now, and this will lead, therefore, to interest in this important national wealth and preserve it, and on this basis we decided carrying out this study to identify the possibility of including dates in the manufacture of sweets. In the research, Al-Zuhdi dates were used, and that the introduction of dates in the manufacture of food products leads to raising the nutritional value of these products and reduces their high cost.

Dates are among the fruits that give high energy due to the high percentage of sugars in them and the low percentage of moisture. Sugars are the main component of dates, which represent 70%.Sugars are a mixture of glucose, fructose, sucrose, and most monosaccharides, which makes them quickly absorbed and easy to digest. They are a good source of iron and potassium, and they also contain They contain sulfur, phosphorus, copper and manganese, and they are also rich in vitamins **(Al-Monsory & Alnedawy, 2020)**. Likewise, the alkaline mineral salts in dates work to neutralize the acidity of the blood resulting from eating starches in abundance and benefit people who suffer from constipation due to the fact that it contains a large percentage of fiber that facilitates bowel movement and helps to expel waste and lowers blood sugar levels. Cholesterol by interfering with bile acid reabsorption and anticoagulation (**Abood & Mohammed, 2017**).

Liquid sugar is a thick sugary solution whose concentration ranges between 70-75% and may reach 80%. It is white, odorless, with natural sweetness, free of salts, and the actual acidity is pH 5.5. It is called Glucose syrup. It is produced from glucose sugar resulting from the hydrolysis and enzymatic decomposition of starch from its various sources such as potatoes, rice, corn and wheat for use in the form of glucose syrup according to the degree of decomposition. A high percentage of fructose sugar, and sugar is distinguished for its nutritional importance, as it reduces the phenomenon of decay, increases the sweetness of the product, and prevents crystallization. It is also directly involved in the manufacture of sweets and caramel, dairy factories, bakeries, and pharmaceutical products. It is also used in the paper and gum industry **(Al-akidi, 2014**).

Pectin is one of the components of the cell wall and the main component is D-galacturonic acid in the formation of α-D in the form of a pyranose ring.

It is economically important in the food industry as a gelling agent widely used in the production of jams, fruit juices, sweets and the manufacture of some pastries, and there is another use of pectin as a stabilizing agent to give a cohesive texture in the manufacture of dairy products and in the manufacture of some medicines **(Al-Bayar *et al.*, 2013) .**

The study aimed to:

1. Studying the chemical composition of Zuhdi dates.
2. The use of liquid sugar in the manufacture of date products.
3. Studying the effect of adding kappa-carrageenan on the chemical, physical and microbiological properties of manufactured pectin candy and selecting the most appropriate form of the treatments.

MATERIALS AND METHODS:

Sources of materials for the experiment:

Importing kappa-carrageenan from Chinese origin , Zuhdi dates from a local orchard, and pectin and sugar from the market.

Preparation of pectin sweets: pectin sweets were prepared from three treatments, including:
The first treatment, control T1, was prepared as a first stage on a laboratory scale by mixing 1.46% of pectin with water 9.55% by means of an electric mixer in batches to prevent agglomeration of pectin. 64 ml of liquid sugar was added, then 20 ml of Zuhdi date juice which prepared by soaking a kilogram of dates (without pits) in 3 liters of water for 24 hours, then squeezing them with a blender. was added. The mixture was heated to 58 °C with Continuous stirring, then citric acid 1.12% is added, and the heating continues at 67 °C to reach the end point with a concentration of 65-68% **(Al-akidi, 2014**).

It is packaged in steam-sterilized glass containers while it is hot and cooled and stored at a temperature of 4 °C without adding a preservative to conduct physiochemical and microbiological tests and date juice is filtered by steeping a kilogram of dates (without pits) to 3 liters Water for 24 hours, then squeezed with a blender **(Obaid,2013)**
The second treatment T2 prepared sweet as in the above method using 50% pectin with 8% kappa-carrageenan of half the quantity from pectin. And the addition of potassium chloride (KCl) (0.037) g

The third treatment T3 replaced the total pectin with 0.1% kappa-carrageenan with the addition of potassium chloride (KCl) 0.074 g, , For 100g of the mixture until a flexible, brittle gel was formed to obtain a jelly sweet.

Chemical analysis

A chemical analysis of the Zuhdi dates and the analysis of the processed pectin sweets were carried out, which included the determination of protein, fat, total ash and moisture according to the standard methods mentioned in **A.O.A.C.** Estimation of total and reducing sugars using the method of Lane-Eynon **(Ruck, 1963).**

Physical analysis

Dissolved solids were estimated using (Abbe Refractometer) ,pH using a pH-meter, total acidity and density using a pycnometer` with a volume of 50 ml at a temperature of 25 °C and compared with the density of distilled water **(Al -Aubadi & Al-Joboury, 2013**), viscosity, electrical conductivity, and turbidity .

Microbiological analysis

Microbiological examinations were carried out for the processed pectin sweet:
Estimating the total number of bacteria by taking 1 gm of pectin sweet, making dilutions, and transferring 0.1 ml of the final product to petri dishes, adding Nutrient Agar medium and incubating at 37 °C for 24 hours.

Coli form bacteria followed the method of pouring the plates using MacConkey agar medium, the dishes were incubated at a temperature of 37 °C for a period of 48-24 hours, yeasts and molds used the medium PDA, the dishes were incubated at a temperature of 22 °C for a period of 5 days (**Abdullah & Abboud, 2017**).

Sensory evaluation

Sensory evaluation was conducted by professors and graduate students in the College of Agriculture - Department of Food Sciences - University of Baghdad according to the sensory evaluation form **(AL-Janabi, 2013**).

Statistical analysis

The statistical program Statistical Analysis System-SAS (2012) was used in the statistical analysis to study the effect of adding kappa-carrageenan to pectin sweets, and the significant differences between the averages were compared with the least significant difference test (Least Significant Differences).

RESULTS AND DISCUSSION:

Chemical analysis of the composition of Al-Zuhdi dates:

(Table, 1) shows the chemical composition of the ascetic classifier (total and reducing sugars, proteins, fats, total ash, and moisture), as their percentages were (70.69, 59.20, 2.68, 0.47, 2.57, and 18.28)%, respectively.

Table (1) The chemical composition of Zuhdi dates.

chemical composition	%Components
Total sugars	70.69
Reducing sugars	59.20
Proteins	2.68
Fat	0.47
total Ash	2.57
Moisture	18.28

The difference in the content of dates may be attributed to the variation of date cultivar, stage of maturity, method of extraction, agricultural treatments, crop service operations, and different genetic origins of date cultivars **(AL-Bekr, 1972)**

Chemical analysis of pectin sweet:

It was noted from Table (2) that there were no significant differences at the level ($P \leq 0.05$) for the treatments T1, T2, T3, total sugars (60.75, 60.05, and 59.12)%, protein (0.63, 0.52, and 0.35)%, and Fats (0.37, 0.36, and 0.38)%, total ash (1.51, 1.58, and 1.66)%, respectively, pH (4.06, 4.14, and 4.16) and total acidity (1.21, 1.18, and 1.15)%, respectively. The difference in the chemical composition of the presence of kappa-carrageenan, as it contains one sulfur group, which leads to the presence of (OH groups) reactive sites for linking kappa-carrageenan to sugars by hydrogen bonds.

We also find that increasing the concentration of carrageenan reduces the percentage of total and reduced sugars; Because of the increase in the associations with sugars. The sugars enhance the conversion of carrageenan into a gel through the OH hydroxyl groups of the sugar, as hydrogen bonds are formed with the carrageenan threads, which facilitates the formation of a region Junction Zone and then gel formation. The salt significantly enhanced the gel strength when added with a certain percentage to kappa-carrageenan, while the excess amount of it leads to a clear reduction in the gel strength **(Yang *et al.*, 2020)**.The amount of ash in dates depends on several factors, including the type of fruits, the type of soil, the irrigation water, the

fertilizer used, and the change in the shape and size of the fruits. Low in fat, and this result is close to what was mentioned by **(Zabar & Borowy, 2012)**, where the percentage of fat in pitted dates was (0.4). The acidity is due to the presence of organic acids such as citric acid and also that carrageenan is a polymer that contains many hydroxyl groups (OH), which makes it weakly acidic, in addition to the sulfur group (SO_3). It has a higher acidic property than the hydroxyl groups that characterize the carrageenan groups (**Kusumaningrum *et al*., 2019).**

Table (2): Chemical tests for pectin sweet.

Compounds	Treatment			LSD
	T1	T2	T3	
Total sugars	60.75	60.05	59.12	2.07NS
Proteins	0.63	0.52	0.35	0.328NS
Total Ash	1.51	1.58	1.66	0.207NS
Fats	0.37	0.36	0.38	0.069NS
pH	4.06	4.14	4.16	0.175NS
total acidity	1.21	1.18	1.15	0.183NS

- ($P \leq 0.05$) (*)
- (N.S) non -significant.
-The numbers represent the mean of three replicates of the sample.

Table (3) indicates that there were no significant differences at the level ($P \leq 0.05$) for the treatments T1, T2, T3, the percentage of dissolved solids was (65, 66, and 69)% and less than what was found (**Al-akidi, 2014**) as the control coefficient for pectin sweet 70%, and the refractive index (1.4570 , 1.4572, and 1.4576), and there were significant differences at the level ($P \leq 0.05$) for the density, as T3 excelled at (1.333) g/ cm^3 compared to T1 and T2, reaching (1.293 and 1.325) g / cm^3, and the melting of the glues It increases with increasing temperature, which leads to an increase in viscosity with a direct relationship. The higher the concentration of the solute , the higher the viscosity. The pH also has a significant effect on the viscosity, as it affects the charges of the hydrophilic ionic aggregates, which affects the degree of solubility **.**

As for the refractive index, it is defined as the amount of change that occurs in the direction of light and depends on the concentration of dissolved solids, and it increases with its increase Heat .There were significant differences at ($P \leq 0.05$) level of viscosity, T3 excelled at (5831) cp compared to T1 and T2 (5388 and 5440) cp. The values of density and viscosity increase with increasing concentration of kappa-carrageenan, sugar molecules and leads to gel formation in carrageenan, and this linking can only occur when the (3,6-anhydro) ring is present. And the low content of sulfur ester makes it have a high ability to form a strong gel in the system. The strongest complexion is due to the higher linear charge, which leads to the formation of complexes that are insoluble in water, and this is consistent with what was stated,(**Silva *et al*., 2016**).

Turbidity and electrical conductivity:

Turbidity is defined as the decrease in the transparency of solutions due to the presence of suspended matter and some dissolved substances such as organic and inorganic compounds of food samples resulting from the addition of components to them, which lead to the reflection and spread of light instead of its transmission in straight lines, and increasing this spread in

light leads to an increase in turbidity. The goal is to identify the purity of the product (**Liu *et al.*, 2020**).

Refer to the results and the presence of significant differences in the turbidity between the treatments, as it reached the highest value of T3 (180) NTU compared to T1 and T2, which amounted to (160 and 165) NTU.

As well as the emergence of significant differences between the electrical conductivity the treatments reached the highest value of T3 (1160) µs / cm compared with the treatment T1 and T2 amounted to (680 and 980) µs / cm, and the electrical conductivity is closely related to the concentration of mineral salts, organic acids, proteins, type and quantity of matter, and it is important in the formation of a three-dimensional network of a gel **.**

Table (3): Physical examinations of pectin sweet.

Compounds	Treatment			LSD
	T1	T2	T3	
Total solids	65	66	69	4.52NS
Refractive index	1.4570	1.4572	1.4576	0.189NS
Density	1.293	1.325	1.333	0.079*
Viscosity	5388	5440	5831	417.33*
Turbidity	160	165	180	14.04*
Electrical conductivity	680	980	1160	91.44*

- (P≤0.05) (*)
- (N.S) non -significant.
-The numbers represent the mean of three replicates of the sample.

Microbiological examinations of bacterial pectin sweet:

The results showed in Table (4) the lack of growth of microorganisms for each of the total number of bacteria, coliform bacteria, yeasts and molds, and this is due to the sterilization conditions that were followed in the industry and the low pH and high concentration of sugar have a role in inhibiting the growth of microorganisms, and this is consistent with what was stated by **(Isah, 2017**).

indicated that polysaccharides resulting from the degradation of kappa-carrageenan showed a clear effect on inhibiting the growth of bacteria, yeasts, and molds **(Wang *et al.*, 2011) .**

Table 4: Microbial tests for pectin sweet**.**

Microbiological examinations cfu/ml	Treatment			LSD
	T1	T2	T3	
The total number of bacteria	0	0	0	0.00NS
Coli Form bacteria	0	0	0	
Yeasts and molds	0	0	0	

- (P≤0.05) (*)
- (N.S) non -significant.
-The numbers represent the mean of three replicates of the sample

Sensory evaluation:

(Table, 5) shows that there are no significant differences at the level (P≤0.05) for the characteristic (appearance and color) for treatments T1, T2, and T3 (18.3, 18.5, and 18.7). The explanation for this is due to the fact that the negative charge of the polysaccharides interacts electrostatically with the dye, and that the color is due to the individual components contained in the product and their interactions .

While there were significant differences in the taste characteristic, where T3 got the highest evaluation score 28.5 compared to the control treatment T1 got 26.9 score, due to the fact that carrageenan, which is known to form a gel, retains flavor, and that the ionic strength and gel strength had an effect on the smell. And carrageenan gel has a longer ability to retain flavour, and this is consistent with what was stated by (**Chakraborty, 2017).**

It was mentioned **(Cortez-Trejo *et al*., 2022**) that the acidity in the products plays a double role by enhancing the flavor and preserving the product, that the carrageenan groups increase their acidity with the increase of the sulfur groups, while the texture of the pectin sweet. Significant differences appeared between the treatments at the level (P≤0.05), as T3 got the highest score 29.7 compared to T1 got the lowest score 25.0. With each type, which plays an important role in the texture of the final product, the kappa type contains one sulfur group.
General acceptance in pectin sweets and the presence of significant differences between parameters T1, T 2, and T3. obtained T3 the highest score 19.3 compared to T1, which obtained 15.5 degrees. The higher the concentration of carrageenan, The higher the concentration of carrageenan, the higher the general acceptance values of the product. This agrees with what was stated by (**Juntachote, 2018**) that the increase in carrageenan in products improves moisture content and water retention capacity due to the formation of a gel, which retains water and enhances the strength of the gel and gives the product its flavor.

The use of aqueous carrageenan colloids as food additives achieves two basic functions, one of which is functional, represented by increasing viscosity, gelation, and emulsion formation, and the other is sensory, represented by improving the appearance, flavor, and texture, as well as the nutritional role of colloids. Therefore, the use of colloids has increased recently in the processes of making baked goods, sweets, and food concentrates for their ability to improve rheological properties, and prolong Storage age and inhibition of microbial growth (**Mohammadian & Alavi, 2016**).

Table (5): Sensory evaluation of pectin sweet.

Treatment	Appearance and color`(20)	Taste (30)	Texture (30)	General admission(20)
T1	18.3	26.9	25.0	15.5
T2	18.5	26.3	27.3	18.9
T3	18.7	28.5	29.7	19.3
LSD	1.52 NS	3.10*	3.91*	2.04*

- (P≤0.05) (*)
- (N.S) non-significant.
-The numbers represent the mean of three replicates of the sample

CONCLUSION:

Kappa-carrageenan is a food additive that improves the rheological properties of the final product by increasing the viscosity and density, which in turn reduces the bitterness and astringent taste of the processed products and retains the color and flavor, and has an effect on the general acceptance in terms of taste and color. Quality because it contains sugars, organic acids, vitamins, mineral elements and antioxidants that have health benefits.

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