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Scientific Research

Application of *Spirulina platensis* algae powder and honey in mango pastille formulation

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ABSTRACT

Pastilles are one of the popular and highly consumed confectionery products that raise concerns due to their low nutritional value.Therefore, the aim of this study was to examine the formulation of mango pastilles with Spirulina platensis powder and honey sweetener. The formulation ingredients included 0 to 20% mango puree, 0 to 10% honey, 5.34% gelatin, Spirulina platensis in the range of 0 to 1%, 23.38% water, 33.5% sucrose, 36.5% glucose, and 1.28% citric acid. The response surface methodology (RSM) and central composite design were used. The results showed that Spirulina platensis powder contains high amounts of protein, ash, and phenolic compounds. The three-dimensional response surface plots showed that moisture significantly increased with an increase in the amount of algae, mango, and honey. The minimum water activity was 0.2 for maximum honey and minimum mango and Spirulina. The maximum water activity was achieved for maximum mango and 8.0% Spirulina and minimum honey. With an increase in the amount of algae, mango, and honey, antioxidant activity, fat, protein, and ash content significantly increased. The highest antioxidant activity was achieved for maximum honey and Spirulina and about half of the mango. The highest firmness was recorded at 2.0% Spirulina and 0.54% mango, and the highest honey content. Firmness decreased slightly with an increase in mango and Spirulina, and then increased with a further increase in mango. The highest color was related to the highest amount of mango and the lowest amount of honey. The highest sensory acceptance was observed at 15.95% mango, 7.97% honey, and 0.80% Spirulina, and the lowest was at 4.05% mango, 2.32% honey, and 0.20% Spirulina. The results of optimizing the functional pastilles showed that the best sample was obtained at 11.67% mango powder, 2.02% honey, and 9.79% Spirulina powder.

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1. Introduction

With increasing concern about weight control and health, people in society try to eat healthier foods. On the other hand, the change in the habits of consumers, including the desire to consume ready meals and snacks, is one of the reasons for the growth and development of new products. Therefore, all kinds of ready-made snacks and snacks, especially pastilles and products, the consumption of which is expanding day by day and is highly liked by different sections of the society, especially children and teenagers. They should be designed in such a way that in addition to having desirable sensory properties, they also have high durability. Also, these snacks should have good nutrients and high nutritional value in order to have a beneficial effect on the health of consumers, especially children.]1[. pStills have long been favored by a wide range of consumers, especially children, who, despite their high acceptance, not only lack nutritional value in terms of having artificial coloring and flavorings, but their consumption also leads to side effects. 2 [.

Today, the exploitation of algae in industrial, agricultural, pharmaceutical and food dimensions has found very wide dimensions and modern technology is used for the production and exploitation of algae in the industrialized and advanced countries of the world. Algae are diverse and important plants and have attracted a lot of attention due to their diverse applications. Due to the existence of large sources of algae in Iran, this plant can be used optimally and beneficially in various fields.]3[. Due to the balance of chemical compounds, microalgae are important biological resources for the production of new products and applications and can be used to improve the nutritional value of food and animal feed. They contain valuable substances such as unsaturated fatty acids, pigments, antioxidants, medicinal compounds and other bioactive compounds.]4[.

micro algae*Spirulina platensis* Inexpensive and rich source of protein, iron, vitaminsB_{12} And it is Landa-linolenic acid, the use of which in the combination of products used by children can improve the level of health and prevent the occurrence of malnutrition in children [5]. Value*Spirulina platensis* Due to the easy digestion caused by the lack of cellulose in the cell wall, other microalgae, including*Chlorella, Ankistrodesmus*[1]*, Selenstrom*[2] *and Sandmos*[3] They lack this advantage. The amount of nucleic acid is one of the concerns about the consumption of microalgae. The amount of nucleic acid in spirulina is lower than other microalgae such as chlorella and sandamos. 65 to 71% of the dry weight of spirulina is protein, while beef has 22% protein. In general, spirulina microalgae have 9-10% moisture, 0.7-0.8% ash, 65-75% protein, 0.2-0.1% fat and some sub-nutrient compounds such as vitamins.6[.

Fruit-based products have been popular as snacks in many parts of the world for years. Fruit products are easy to eat, have a good mouth feel and are beneficial for health. Fruit puree is usually used in the formulation of these products. Fresh fruits are ideal snacks, but their distribution and storage and their seasonality are among the biggest problems in their use and availability [7].

[1] -Ankistrodesmus

[2] -Selenastrum

[3] -Scenedesmus

Mango with scientific name (*Indica Mangifera*) is a tropical fruit. The origin of mango is the peninsula of India, Pakistan, Bangladesh and Southeast Asia. The southern and southeastern regions of Iran, including the provinces of Sistan and Baluchistan, Hormozgan and Jiroft region, have been identified as potential areas for the production of this product. Today, this tree is cultivated in many tropical countries and its fruit is exported all over the world [8]. Mango fruit contains beta-carotene (640 micrograms), vitamin C (25,000 micrograms) and vitamin A (3500 units), which are antioxidants and help prevent free radical damage and thus reduce the risk of some cancers. Various products such as jam, compote, pastille, extract and various types of seasonings are made from mango fruit [9].

Honey contains antioxidants such as beta-carotene. Vitamin C, uric acid and many minerals that play a role in lipid metabolism, these substances may increase the catabolism of fats and decrease their serum levels. Basically, the mechanism of action of honey is not known. However, it contains many trace elements such as zinc, copper, antioxidants and many other substances. The fructose and glucose content of honey can play an important role in its effect [1]. Due to the many advantages that spirulina algae has, it can be used in food products such as mango paste to increase the nutritional value and improve the quality characteristics, and also use honey instead of sugar. The purpose of this research is to investigate the formulation of mango pastille with algae powder*Spirulina platensis* It was with honey.

2- Materials and methods

1-2- Materials

In this research, dried and powdered algae approved by experts from Algae bankwas prepared and relevant tests were conducted. Mango and honey used in the market and chemicals that include:DPPH، Folin Sieve Caltio, sodium carbonate, citric acid, sodium hydroxide, phenolphthalein, ethanol, sodium hydroxideSodium sulfate، Copper sulfate, ammonium borate، Hydrochloric acid AndPetroleum ether was from The German company Merck was purchased.

2-2- Methods

In order to produce fruit paste based on mango puree, first mangoes were washed, peeled and cut into pieces. Then these pieces were crushed in a grinder. Then, the chopped mango was heated at 85°C for one minute to inactivate the enzymes. powder*Spirulina platensis*5.34% gelatin was mixed with Bloom 290 and 33.5% sucrose by weight and 36.5% glucose by weight (while applying heat at 70 degrees Celsius). Also, the distilled water used was 38 It will be 23% by weight. At the end, after adjusting the pH to 3.4 by adding citric acid with a concentration of 40 M at the rate of 1.28% w/w and controlling the Brix degree to a constant Brix of 45, the mixture was prepared. Then mix The prepared mixture was poured into steel mesh molds in holes with dimensions of 1.2 x 2 x 2 cm and the molds were placed in the refrigerator at 4 degrees Celsius for 2 hours to seal the gel. Then, the resulting gel was removed from the holes of the mold and the samples were dried for 6 hours at a temperature of 70 degrees Celsius in a hot air dryer with an air circulation speed of 1.5 m/s. The drying operation was done in order to reduce the moisture content of the final product to 20-23% and also to increase the shelf life of pastilles.

1-3-2- Algae powder tests*Spirulina platensis*

1-1-3-2- Determining the moisture content of algae powder

Humidity was measured according to Iran's national standard No. 2705. For this purpose, a certain amount of the sample was accurately weighed and kept in an oven with a temperature of 105 degrees Celsius until a constant weight was reached. The moisture content of the samples was obtained by calculating the difference between the initial weight and the fixed weight.

2-1-3-2- Algae powder ash measurement

For this purpose, 3 grams of the sample was accurately weighed and after burning on the flame, it was placed in an electric furnace with a temperature of 450 degrees Celsius, and the temperature of the furnace was gradually increased to 550 degrees Celsius until the sample reached a constant weight at the same temperature. was kept Then the sample was placed in the desiccator. After cooling, its weight was determined]10[.

3-1-3-2- Algae powder protein measurement

The amount of pastille protein according to the methodAACC (2010) It was determined. 6 grams of spirulina algae powder was weighed and placed inside a Kjeldahl balloon. To determine the percentage of protein, the obtained percentage of nitrogen should be multiplied by the protein factor (6.25).]10[.

4-1-3-2- Algae powder fat measurement

3 grams of spirulina algae powder was accurately weighed in a fat-free thimble, its opening was loosely covered with glass wool, the thimble was placed in the extractor and enough petroleum ether was added to siphon it once. Next, the refrigerant was connected. Then the assembly was placed on an electric heater to boil slowly and the extraction chamber was filled and emptied at least 10 times.]10[.

5-1-3-2- Measurement of total phenolic compounds

The existing phenolic compounds were measured using Folin Ciocaltio reagent and based on gallic acid, by a spectrophotometer at a wavelength of 765 nm. 0.5 ml of the sample was mixed well with 5 ml of folinciocaltio reagent and 4 ml of 1 M sodium carbonate solution. The mixture was kept at room temperature for 15 minutes. Then, the absorption value of the solution was read by a spectrophotometer at a wavelength of 765 nm. The total amount of phenolic compounds was expressed using a standard curve based on gallic acid and expressed as milligrams per gram of oily sample.]11[.

2-3-1-6- Measurement of antioxidant properties

Antioxidant activity of pastille using the method of 2 and 2 diphenyl 1-picrylhydrazyl based on the inhibition percentage of free radical production (DPPH) was measured. First, different concentrations were prepared. Then pastille with stock solutionDPPH The mixture was shaken for 30 minutes in the dark by a shaker. After this period of time, the absorbance of the samples was read at a wavelength of 517 nm using a spectrophotometer. percent inhibitionDPPH It was calculated by the relation 1-4]12[:

$$\text{DPPH Inhibition}(\%) = [1 - \frac{AA}{AB}] \times 100$$

Relationship 3-1

AA: sample absorption,AB: witness absorption = initial absorptionDPPH alone

2-3-2- Measurement of pastille chemical properties

1-2-3-2- humidity

Humidity was measured according to Iran's national standard number 2682. For this purpose, 10 grams of crushed pastille sample was weighed in plates with a specific weight and placed in an oven with a temperature of 105 degrees Celsius for 3 hours. Sample dryingIt was done until a constant weight was reached. After drying and cooling in the desiccator, the plates were weighed and the humidity was calculated from equation 2-3 on the day after baking.

$$percentage\ humidity = \frac{B-C}{B-A} \times 100$$

Relationship 3-2

A: weight of empty plant,B: sample weight with container before drying,C: Weight of sample with container after drying

2-2-3-2- Determination of water activity

The water activity of the samples was measured using a water activity device. Water activity was done in two hours after preparing the product [13].

2-2-3-3- Determination of protein

The amount of pastille protein according to the method13- 46 AACC (2010) Was determined.

2-2-3-4- determination of fat

The amount of pastille fat based on the method10- 30 AACC (2010) Was determined.

2-2-3-5- ash measurement

The measurement of ash was carried out according to the national standard of Iran No. 2682. For this purpose, a container of dry and clean ash was heated in an oven at 100 degrees Celsius for one hour and cooled in a desiccator. The amount of 2 to 3 grams of pastille sample was weighed in a special container for ash. The crucible or container for ash was burned slowly on the laboratory flame under the hood until the smoke disappeared. The container containing the sample was heated for 6 hours in an electric furnace at 550 to 600 degrees Celsius until light ash was formed. The container was placed in a desiccator to cool and then weighed and the amount of ash was calculated according to equation 3-3.

$$Ash\ percentage = \frac{Ash\ containing\ bush\ weight - china\ bush\ weight}{Sample\ weight} \times 100$$

(Relation 3-3)

3-3-2- Measuring the physical properties of pastilles

1-3-3-2- texture

The histometer test was performed using a histometer. For this purpose, in all samples, first, cube pieces with dimensions of 40×40×2mm was prepared. Next, the samples were subjected to a compression test under a cylindrical aluminum prop with a diameter of 25 mm. During the test, the speed of the prop was 30 mm/min, the amount of compression was 20 mm, and the starting threshold was 50 grams. The maximum force required to apply this compression was recorded as an index of the stiffness of the sample in terms of newtons. This test was performed within 2 hours after keeping the pastille at room temperature]14[.

2-3-3-2- Color

Color was measured using Huntlab system. Huntlab based on three indicatorsL^*،a^*،b^*, is used to evaluate the color. The sample was placed on a transparent glass plate and the numbers corresponding to 3 points were read. The color before and after the process in the refrigerator will be randomly determined at three points and their average will be reported. The overall color change was calculated as follows [15]:

$$\Delta E = \sqrt{(L^*-L0^*)2 + (a^*-a0^*)2 + (b^*-b0^*)2}$$

2-3-4- Pastille sensory evaluation

Pastille samples that were coded randomly are evaluated by a sensory group of acceptance, the evaluators of the acceptance group included 10 semi-trained judges. Pastille was evaluated from the point of view of taste, smell, color, texture and overall acceptance based on a 5-point hedonic scale (1=most unfavorable, 5=most favorable). Pastille pieces were cut into standard bite-size pieces and placed in air-tight plastic containers to equilibrate for 2 hours at room temperature before evaluation. The evaluators used distilled water at ambient temperature to wash the mouth between the samples [2].

2-3-5- Data analysis

All statistical analyzes by softwareDesign Expert will be done. In this research, the response level method (RSM) central composite design was used. To draw graphs from the softwareDesign Expert used.

3. Results and Discussion

1-3- Investigating the characteristics of algae powder

Chemical compounds of algae*Spirulina platensis* It is given in Table 3-1. As can be seen, algae powder contains high amounts of protein, ash and phenolic compounds.

Table 3-1 chemical compounds of Spirulina platensis algae.

Property	Amount (g / 100g)
humidity (%)	7
ash (%)	19
protein (%)	60
fat (%)	5
carbohydrate (%).	17
Total phenolic compounds	450mg

About 60-70% of the dry weight of spirulina is protein.Spirulina platensis algae has 460-630 grams of protein per kilogram of dry matter. Therefore, this food can be used as an important protein source in animal and human nutritionToday, spirulina is used in cookies, breads, salads and soups, and in European countries, spirulina tablets are taken daily to improve the diet. Considering the population growth and the lack of agricultural resources in the land, these methods can help in the optimal use of resources.]16[.

The results of adding different levels of algae powder*Spirulina platensis* on sponge cake by Zangeneh et al. (2018), showed that the antioxidant potential and the amount of total phenol of sponge cake samples increased with the percentage of algae powder.*Spirulina platensis* It increased compared to the control sample. The reason for the increase in total phenol of sponge cake containing algae*Spirulina platensis* attributed to the high amount of phytochemical and biologically active substances such as flavonoids, sterols and other phenolic compounds]17[. ResultsArticle et al. (2021) showed that with increasing algae concentration*Spirulina platensis* In kefir, the total phenolic content showed a significant increase]18[.

2-3- Pastel humidity

3D response surface plots for humidity**Mango paste with algae powder*Spirulina platensis* with honey**It is presented in Figure 1. According to the results, when the concentration of algae powder is constant, with the increase in the amount of mango and honey, the humidity increased significantly. Also, the humidity

increased linearly with the increase in the amount of algae.

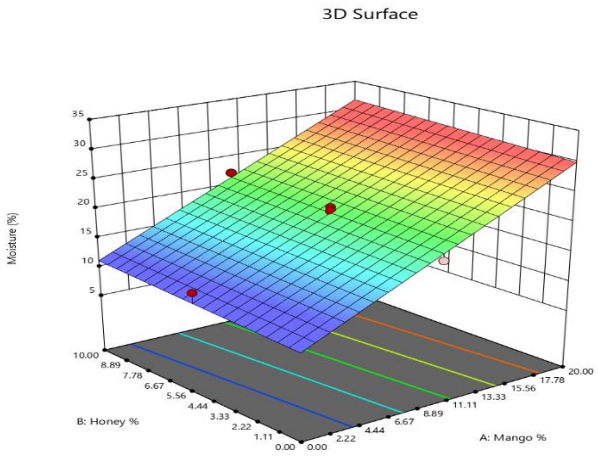

Figure 1 Three-dimensional response surface diagrams for the moisture content of mango pastille with *Spirulina platensis* algae powder and honey.

Algae powder*Spirulina platensis* Able to improve moisture retention. LikelyHydrocolloid compounds in microalgae*Spirulina platensis*, reduce the loss of moisture in pastilles]19[. In 2015, Khazaipol et al. by investigating different levels of microalgae*Spirulina platensis* On the physicochemical properties of kiwi paste, they showed that moisture increased due to the addition of spirulina.]20[. alsoScore et al. (2015) stated that the hydrocolloid compounds present in*Spirulina platensis*It reduces moisture loss in Yazdi cake]19[.

3-3- pastel blue activity

3D response surface plots forWater activity**Mango paste with algae powder*Spirulina platensis* with honey** It is presented in Figure 2.The lowest amount of water activity for maximum honey and minimum mango and spirulina is 0.2%. With the increase of spirulina, total water activity increased up to 0.8%, and the highest water activity was in maximum mango, 0.8% spirulina, and minimum honey (reduced grade 2 model).

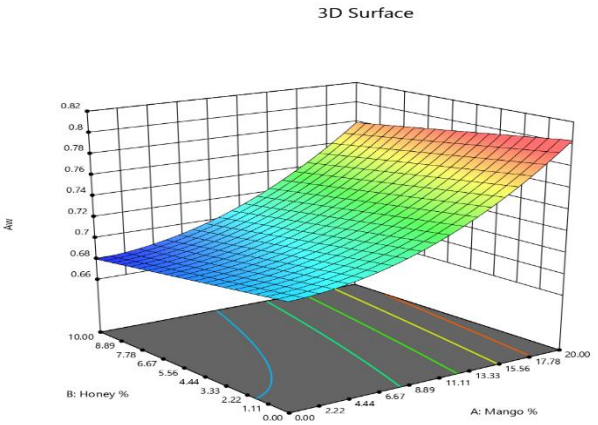

Figure 2. 3D response surface diagrams for water activity of mango pastille with *Spirulina platensis* algae powder with honey.

The water activity of pastille samples in this research varies in the range of 0.7-0.6, which is within the range of safe storage. It is generally accepted that water activity should be less than 0.6 and moisture content should be less than 20% to ensure stability.According to the resultsKhazaipol et al. (2014) The effect of microalgae *Spirulina platensis* , agar and guar hydrocolloids were significant on the activity of fruit pastille juice based on kiwi puree]20[.

3-4- Pastille fat

3D response surface plots for fat**Mango paste with algae powder*Spirulina platensis* with honey** It is presented in Figure 3. When the concentration of algae powder is constant, the fat increased significantly with the increase of mango and honey. Also, with the increase in the amount of algae, the fat increased linearly. Also, by reducing each of the compounds, the amount of fat decreased.

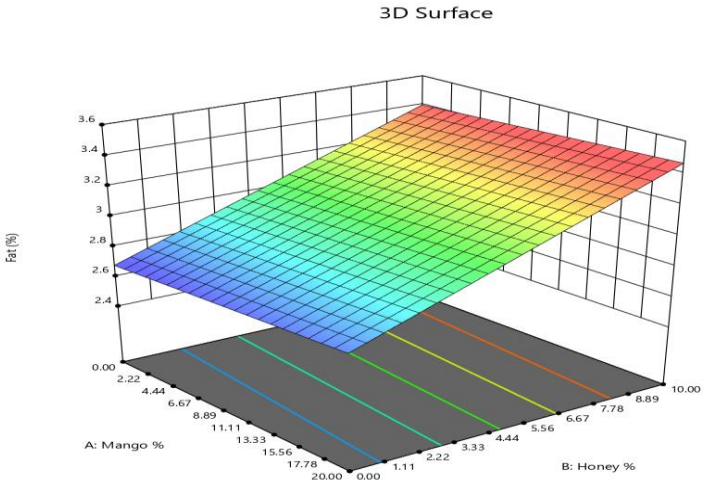

Figure 3. Three-dimensional response surface plots for mango pastille fat with *Spirulina platensis* algae powder and honey.

The amount of fat in different pastille samplesThis research was in the range of 2.7-3.4 percent.

3-5- pastille protein

3D response surface plots for proteins**Mango paste with algae powder*Spirulina platensis* honey** It is presented in Figure 4. When the concentration of algae powder is constant, with the increase of mango and honey, the protein increased significantly. Also, by increasing the amount of algae, protein increasesAnd with that decreaseFound.The highest amount of protein was in the highest amount of honey, mango and spirulina (reduced grade 2 model).

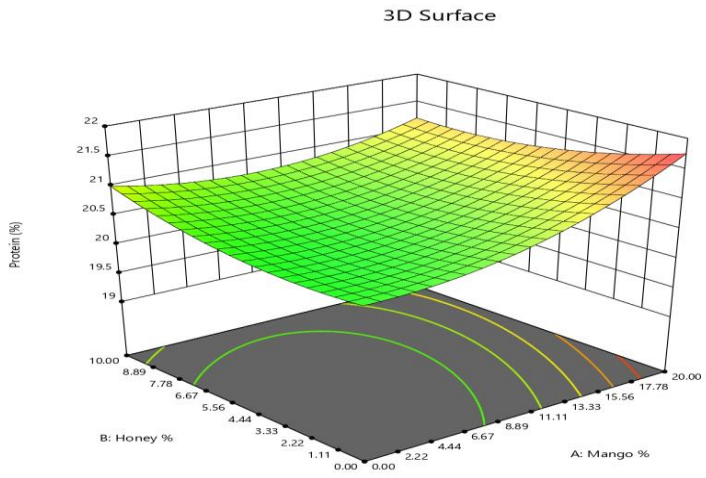

Figure 4. 3D response surface plots for mango pastille protein with *Spirulina platensis* algae powder with honey.

The amount of protein in different pastille samplesThis research was in the range of 19.28-21.69 percent. Mohammadi Al-Sati et al. (2015)They showed that the protein and iron of yogurt samples enriched with microalgae*Spirulina platensis* increased]21[. Zanganeh et al. (2019) reported *Spirulina platensis* It contains a high amount of protein, which increases the amount of protein with increasing levels*Spirulina platensis* It weakens the gluten network, and this causes a denser structure of the cake and a decrease in its volume]18[. Eslami et al. (2014) showed that the addition of algae*Spirulina platensis* influenceYPositive effect on protein contentYProbiotic buttermilk had N and iron]22[.

6-3- pastel ash

3D response surface plots for ash**Mango paste with algae powder*Spirulina platensis* with honey** It is presented in Figure 5. When the concentration of algae powder is constant, ash increased significantly with the increase of mango and honey. Also, with increasing amount of algae, ash increased linearly.

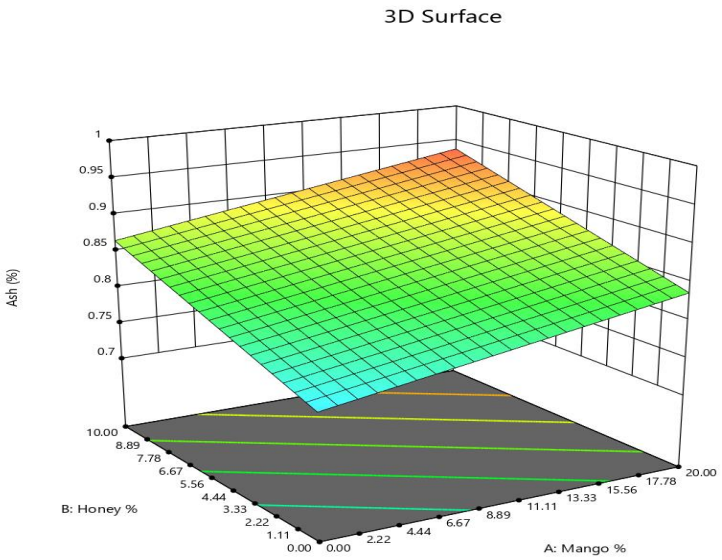

Figure 5. 3D response surface plots for mango pastille ash with Spirulina platensis algae powder and honey .

The amount of ash in different pastille samplesThis research was in the range of 0.7-0.9 percent.

7-3- **Antioxidant capacity of pastille**

3D response surface plots for antioxidant properties **Mango paste with algae powder*Spirulina platensis* with honey**It is presented in Figure 6. When the concentration of algae powder is constant, with increasing amount of mango and honey, the antioxidant property increased significantly. Also, by increasing the amount of algae, antioxidant properties Increased.Antioxidant capacity with increasing honey and spirulina and about half of mango is the highest amount and the lowest amount is 4.05% for mango, 2.03% for honey and 0.2% for spirulina. (reduced grade 2 model).

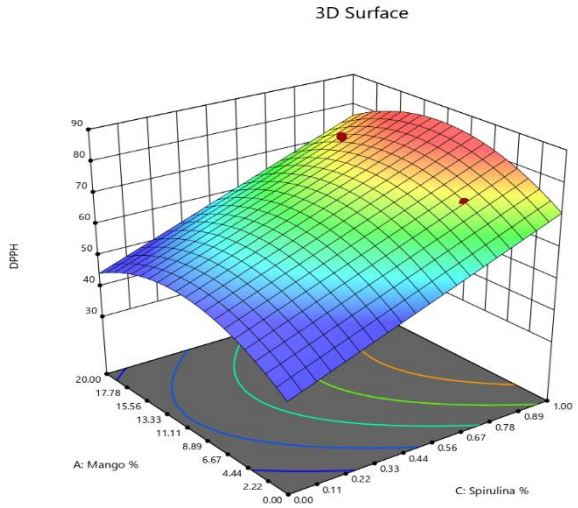

Figure 6. Three-dimensional response surface diagrams for the antioxidant capasity of mango pastille with *Spirulina platensis* algae powder and honey.

Antioxidant capacity of different pastille samplesThis research was in the range of 52-82%. Salehifar et al. (2012) reported that algal alcoholic extract*Spirulina platensis* compared to chemical antioxidants such as butylated hydroxyanisole (THERE WERE) and beta-carotene and its aqueous extract had more antioxidant effect than gallic acid and chlorogenic acid.]23[. The results of adding algae powder*Spirulina platensis* on the amount of total phenol of sponge cake showed that the antioxidant potential of sponge cake increased with the increase of algae powder*Spirulina platensis* Increased]18[.

Safari et al. (2019) showed that phycocyanin (C-PC) Of*Spirulina platensis* It has a high potential of antioxidant activity in laboratory conditions and can be used as an antioxidant in all kinds of foods.]12[.

8-3- The stiffness of pastille tissue

3D response surface plots for stiffness**Mango paste with algae powder*Spirulina platensis* with honey**It is presented in Figure 7.The highest amount of hardness was reported in 0.2% of spirulina and 4.05% of mango and the highest amount of honey. By increasing mango and spirulina to about half, the stiffness of the tissue decreased to a small amount, and then with a further increase of mango, the stiffness increased (reduced degree 2 model).

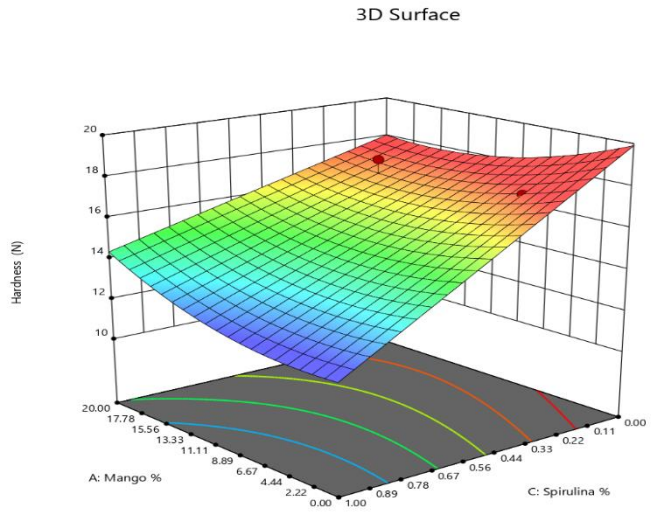

Figure 7. Three-dimensional response surface diagrams for firmness of mango pastille texture with *Spirulina platensis* algae powder and honey.

The degree of hardness of different pastille samplesThis research was in the range of 12-17 newtons. Having polar groups, spirulina has trapped the water in the formulation in its structure and ultimately led to an upward trend in the amount of viscosity, firmness and stability of the texture of the samples.]18[.

9-3- pastel color characteristics

3D response surface plots for color changes**Mango paste with algae powder*Spirulina platensis* with honey**It is presented in Figure 8. When the concentration of algae powder is constant, the color changes increased significantly with the increase of mango and honey.The highest color was related to the highest amount of mango and the lowest amount of honey. Color changes when spirulina is 0.2%, the greatest increase is in the maximum of mango and honey, and with the increase of spirulina, the behavior of the graph changed (model 2be).

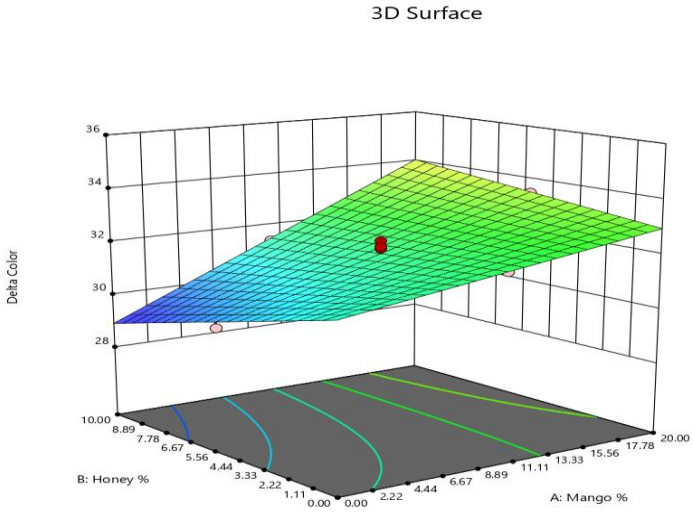

Figure 8-3. Three-dimensional response surface diagrams for color changes of mango pastille with *Spirulina platensis* algae powder and natural honey sweetener.

As it can be observed, with the replacement of algae, the color changes of the final product were reduced due to its ability to retain and preserve moisture and prevent water from escaping. LevelΔE Different examples of pastillesThis research was in the range of 29-35. Therefore, it can be made from algae*Spirulina platensis*It was used as a colorant (its pigment is phycocyanin) in food products]18[.

Phycocyanin is a blue pigment, light absorber with antioxidant and fluorescent properties*Spirulina platensis* Is. Phycocyanin has been used as a colorant in foods such as chewing gum, ice syrup, soft drinks, candy, cosmetics, and diets.]24[.

Khazaipol et al. (2014) by investigating the effect of different levels of microalgae*Spirulina platensis* and agar and guar hydrocolloids on the color parameters of fruit paste based on kiwi puree found the effect of microalgae*Spirulina platensis*In all levels added to all three color parametersL* ، a* Andb* It was meaningful]20[. resultsMohammadi Al-Sati et al. (2015)showed that*Spirulina platensis* on the parametersb* ، a* AndL*The color of the yogurt samples was effective, while reducing the viscosity of the samples]21[. The results are in agreement with Zanganeh's findingset al. (2019)Was.

theyIn research effectsAdding different levels of algae powder*Spirulina platensis* on the color changes of sponge cake samplesexamined andshowed that with increasing levels of different algae*Spirulina platensis* To the sponge cake, the samples became greener]18[.

10-3- Sensory characteristics of pastel

3D response surface plots for sensory attributes**Mango paste with algae powder*Spirulina platensis* with honey** It is presented in Figure 9. When the concentration of algae powder is constant, with the increase of mango and honey, the moisture content increased significantly. Also, the humidity increased linearly with the increase in the amount of algae.The highest amount of sensory acceptance was observed in 15.95% of mango, 7.97% of honey and 0.8% of spirulina, and the lowest amount was reported in 4.05% of mango, 2.03% of honey and 0.2% of spirulina (model Grade 2 reduced).

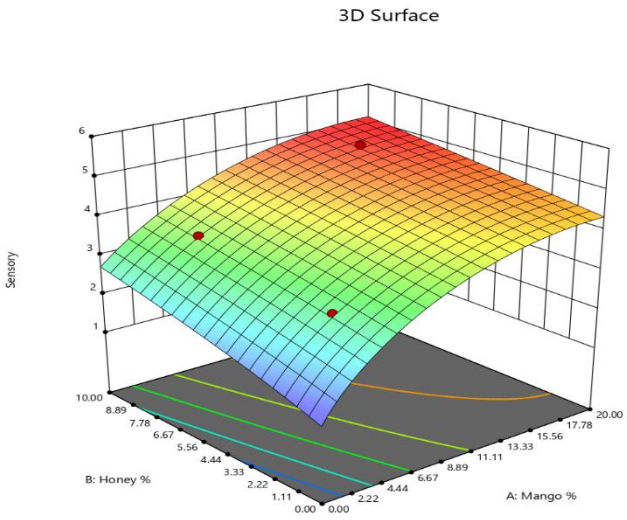

Figure 9. Three-dimensional response surface diagrams for the sensory characteristics of mango pastille with *Spirulina platensis* algae powder and honey.

The sensory evaluation of the samples showed that the addition of algae, mango and honey does not have an adverse effect on the sensory characteristics of the sample such as aroma, taste and color. The overall acceptance score of different pastille samples in this research was in the range of 1-5.9.

Khazaipol et al. (2014) by investigating the effect of different levels of microalgae*Spirulina platensis* Samples containing 0.25 and 0.5% were found on fruit paste based on kiwi puree*Spirulina platensis* They had more overall acceptance than samples without spirulina]20[.

In 2015, Khazaipol et al. by investigating different levels of microalgae*Spirulina platensis* On the sensory characteristics of kiwi paste, they showed that samples containing 0.25% spirulina had better sensory characteristics (color, aroma, taste and overall acceptance) than other samples.]20[.

4 - Conclusion

Three-dimensional response surface graphs showed that moisture, fat, protein and antioxidant property increased with increasing amount of algae, mango and honey. The lowest amount of water activity for maximum honey and minimum mango and spirulina is 0.2%. With the increase of spirulina, the total water activity increased up to 0.8%. With the increase of mango and spirulina, the hardness decreased slightly, and then with the increase of mango, the hardness increased. The highest color was related to the highest amount of mango and the lowest amount of honey. The highest amount of sensory acceptance was observed in 15.95% of mango, 7.97% of honey and 0.8% of spirulina. The results of the optimization of Farasamand paste showed that the best sample is obtained in 11.67% of mango powder, 2.02% of honey and 0.79% of spirulina algae powder.

5- Resources

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مقاله علمی_پژوهشی

کاربرد پودر جلبک *اسپیرولینا پلاتنسیس* (***Spirulina platensis***) و عسل در فرمولاسیون پاستیل انبه

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چکیده

پاستیل‌ها از جمله فراورده های قنادی محبوب و پر مصرف می‌باشند که مصرف بالای آنها، به دلیل ارزش تغذیه‌ای پایین موجب برخی نگرانیها می‌شود. لذا هدف از این مطالعه بررسی فرمولاسیون پاستیل انبه با پودر جلبک اسپیرولینا پلاتنسیس به همراه شیرین‌کننده عسل بود. اجزای فرمولاسیون شامل ۰ تا ۲۰٪ پوره انبه، ۰ تا ۱۰٪ عسل، ۵/۳۴٪ ژلاتین، اسپیرولینا پلاتنسیس در بازه (۰ تا ۱٪) و ۲۳/۳۸٪ آب، ۳۳/۵ ساکارز، ۳۶/۵٪ گلوکز و۱/۲۸٪ سیتریک اسید بود. از روش سطح پاسخ (RSM) و طرح مرکب مرکزی استفاده شد. نتایج نشان داد پودر جلبک اسپیرولینا پلاتنسیس حاوی مقادیر بالایی پروتئین، خاکستر و ترکیبات فنولی است. نمودارهای سطح پاسخ سه بعدی نشان داد با افزایش میزان جلبک، انبه و عسل، رطوبت بطور چشمگیری افزایش می‌یابد. کمترین میزان فعالیت آبی برای حداکثر عسل و حداقل انبه و اسپیرولینا ۰/۲ درصد است. بیشترین فعالیت آبی برای حداکثر انبه و ۰/۸ درصد اسپیرولینا و حداقل عسل بود. با افزایش میزان جلبک، انبه و عسل، فعالیت آنتی اکسیدانی و چربی و پروتئین و خاکستر بطور چشمگیری افزایش یافت. فعالیت آنتی اکسیدانی با افزایش عسل و اسپیرولینا و حدود نصف انبه بیشترین مقدار و کمترین مقدار هم برای انبه ۴/۰۵ درصد، عسل ۲/۰۳ درصد و اسپیرولینا ۰/۲ درصد است. بیشترین مقدار سفتی در ۰/۲ درصد اسپیرولینا و ۴/۰۵ درصد انبه و بیشترین مقدار عسل گزارش شد. با افزایش انبه و اسپیرولینا، سفتی به میزان کم کاهش و سپس با افزایش بیشتر انبه سفتی افزایش پیدا کرد. بیشترین رنگ مربوط به بیشترین مقدار انبه و کمترین مقدار عسل بود. بیشترین مقدار پذیرش حسی در ۱۵/۹۵ درصد انبه، ۷/۹۷ درصد عسل و ۰/۸ درصد اسپیرولینا مشاهده شد و کمترین مقدار هم در ۴/۰۵ درصد انبه، ۲/۰۳ درصد عسل و ۰/۲ درصد اسپیرولینا گزارش شد. نتایج حاصل از بهینه سازی پاستیل فراسودمند نشان داد بهترین نمونه در ۱۱/۶۷ درصد پودر انبه، ۲/۰۲ درصد عسل و ۰/۷۹ درصد پودر جلبک اسپیرولینا بدست می‌آید.