EFFECT OF PHYSICAL PROPERTIES OF WHEY PROTEIN ISOLATE BASED COATING ON GUAVA (*Psidium guajava* L.)

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ABSTRACT

In this study, evaluation of different physical properties of whey protein isolate based coating on guava (Psidium guajava L.) fruit was carried out. The physical properties of fresh guava and edible coating material were studied. Properties of fresh guava like length, width, thickness, size, sphericity and volume were measured. Properties of coating materials like density, viscosity and coating thickness were determined. The average value of length, width, thickness, size, sphericity and volume of the guava fruit was measured 58.53 mm, 62.60 mm, 61.84 mm, 60.70 mm, 0.97 and 121.7cm^3, respectively. The average value for coating solution viscosity was found to be 0.193, 0.156 and 0.088 Pa.s, density was recorded to be 1.06, 1.051 and 1.024 g/cm^3 and coating thickness was found to be 0.021, 0.019 and 0.017 mm for coating composition ratio 40+(30:30), 50+(25:25) and 60+(20:20), respectively. It was found that the coating thickness varied with viscosity, density and coating composition ratio of the solution.

KEY WORDS: Edible coating, Glycerol, Guava, Physical properties, Whey protein isolates

INTRODUCTION

Guava (*Psidium guajava* L.) belongs to Myrtaceae family and very popular fruit in India. Guava fruit is rich in minerals like phosphorus (23.37 mg/100 g), calcium (14-30 mg/ 100 g) as well as vitamin like niacin, pantothenic acid, thiamine, riboflavin and vitamin A (Bose *et al*., 1999). Guava contains four times more vitamin C as compared to citrus fruits (Adress *et al*., 2010). Guava is used in processed products like clarified juice, canned, jam, jelly, dehydrated powder etc. Guava is one of the most nutritious and delicious fruit, liked by the consumer for its refreshing taste and pleasant flavour.

Whey proteins are a by-product from the cheese industry and consists of whey protein isolates (WPI) which represent the purest form of such proteins. Whey is a liquid by product of cheese production which is a source of valuable nutritional proteins. Whey protein isolate is the concentrated whey powder containing high percentages of protein (>90%) and water soluble over wide range of pH (Tunick, 2008).

Edible coatings are thin layers applied to the fruits surface for natural

protective waxy coatings. The mechanism by which edible coatings preserve fruits is the establishment of a modified atmosphere around the product, which serves as a partial barrier to O_2 and CO_2, water vapor and aroma compounds, decreasing the respiration rate of the fruit and water loss and preserving texture and flavour. It is used to improve handling properties, prevent moisture loss, increase the shelf life and reduce the need of packaging material during transport (Olivas *et al.*, 2008). Coating thickness depends on the solution properties such as density, viscosity, and surface tension of the coating solution (Cisneros and Krochta, 2003).

MATERIALS AND METHODS

Raw material

Fresh guava (variety L-49) fruits were harvested at maturity stage (when skin colour changes from dark green to light green) from a fruit research center, sakkarbaug at Junagadh and transported under ambient conditions to the laboratory at processing and food engineering department, CAET, Junagadh. Diseased, damaged and extremely large or small fruits were discarded. Whey protein isolate was purchased from Global Healthfit Retail India LLP, New Delhi.

Preparation of coating solution

WPI and glycerol were dissolved in distilled water with continuous stirring. Coating composition water (%) + WPI : GLY (g:ml) was taken as independent parameter like 40 + (30:30), 50 + (25:25) and 60 + (20:20). Then, the solution was heated to different temperature like 80°C, 90°C and 100°C and stirred continuously. After heating, solution was rapidly cooled in an ice bath for 10–15 min to avoid further denaturation. Then the solution was filtered through two layers of muslin cloth to remove any coagulation.

Physical properties of guava fruit

Size

Size of the guava fruit was measured with the help of digital Vernier Calipers (Mitutoyo corporation, Japan made, model-CD-12"), having accuracy of 0.01 mm. Dimensions like length, width and thickness were recorded in millimeter. The size of the fresh guava fruit was determined by the following equation.

$$\textbf{Size, D (mm)} = (\textbf{lbh})^{\frac{1}{3}}$$

Sphericity

The sphericity of guava fruit was determined by using the equation given below with three dimensions as length, width and thickness of guava (Kabas *et al*., 2006).

$$\textbf{Sphericity, } \varepsilon \text{ (\%)} \quad \frac{(\textbf{lbh})^{\frac{1}{3}}}{\textbf{l}} \quad \textbf{X 100}$$

Volume

Guava fruit volume was determined by water displacement method described by Mohsenin (1986). Weigh a container of distilled water, allowing enough space for fruit submersion (weight of container + water = W_1). Then submerge fruit while container is still on the scale. To avoid air bubbles, put few drops of wetting agent or detergent in the water to reduce surface tension (Keep fruit from touching the sides or bottom of the container). Read the weight of the container plus the water plus the submerged fruit (weight of container + water + guava fruit = W_2). The difference in grams between the two weights is equal to the volume of the guava fruit in cubic centimeters (cm^3). True volume was determined by following equation.

$$\textit{True volume } (cm^3) = \frac{\textit{Weight of displaced water } (g)}{\textit{Density of water } (g/cm^3)}$$

Physical properties of coating material

Viscosity

Viscosity of prepared solutions were measured in centipoises by using Brookfield DV-III Ultra Rheometer, available at Food

Testing Laboratory, JAU, Junagadh. The sample was placed in a small sample adapter. The viscometer was operated at speed range of 50 - 250 rpm and viscosity reading was taken directly from the instrument. Rheological measurements in terms of viscosity were made at different concentrations of water (%) + WPI:GLY (g:ml) [40 + (30:30), 50 + (25:25), 60 + (20:20)].

Density

Density of the coating solution was calculated by measuring the mass of the solution in gram by using weight balance and volume was measured by using graduated cylinder in milliliter. Density was calculated by the following expression:

Density (gm/cm^3) = Mass of the solution/ Volume of solution

Coating thickness

Coating thickness was determined by water displacement method. The displaced water was measured in terms of cubic centimeter by measuring the volume of uncoated guava and coated guava by displaced water. The difference between initial and final volume gives the volume of applied coating as under and thickness was found in mm. The coating thickness was determined by following expression:

Coating thickness $t = W_f - W_i$

Where; W_f = Weight of coated guava

W_i=Weight of uncoated guava

RESULTS AND DISCUSSION

The results of physical properties of fresh guava like length, width, thickness, size, sphericity and volume of fresh guava fruits are presented in Table 1. The dimensions like length, width and thickness of guava were measured and express in mm. The maximum length, width and thickness of the guava fruit was recorded to be 61.72 mm, 67.22 mm and 67.16 mm, whereas, minimum was 55.34 mm, 57.13 mm and 57.05 mm, respectively.

The average value of length, width and thickness of the guava fruit was measured 58.53 mm, 62.60 mm and 61.84 mm, respectively. The average size, volume and sphericity of the guava were found to be 60.70 mm, 121.7 cm^3 and 0.97, respectively and values ranged from 56.61 to 63.63 mm, 98.2 to 143.7 cm^3 and 0.94 to 0.99.

Physical properties of Whey protein isolate based coating material

Variation in viscosity of WPI coating

The results for viscosity of Whey protein isolate coating with different proportion were recorded and presented in Table 2. The viscosity of coating material was found to be 0.128, 0.173 and 0.280 Pa.s for 40 + (30:30) ratio of Water + (WPI:Gly) coating composition at 80°C, 90°C and 100°C, respectively. For 50 + (25:25) ratio of Water + (WPI:Gly) coating composition, viscosity was found to be 0.136, 0.157 and 0.177 Pa.s at 80°C, 90°C and 100°C, respectively, whereas at 60 + (20:20) ratio of Water + (WPI:Gly) coating composition, viscosity was found to be 0.077, 0.087 and 0.100 Pa.s at 80°C, 90°C and 100°C, respectively. These results showed that as solution of temperature increased, viscosity was also increased, while the proportion of water increased, viscosity decreased.

Variation in density of WPI coating

The results for density of Whey protein isolate coating with different proportion were recorded and presented in Table 2. The density of coating material was found to be 1.053, 1.062 and 1.065 g/cm^3 for 40 + (30:30) ratio of Water + (WPI:Gly) coating composition at 80°C, 90°C and 100°Cm respectively. For 50 + (25:25) ratio of Water + (WPI:Gly) coating composition, density was found to be 1.044, 1.05 and 1.059g/cm^3at 80°C, 90°C and 100°C, respectively, whereas at 60 + (20:20) ratio of Water + (WPI:Gly) coating composition, density was found to be 1.017, 1.021 and 1.034 g/cm^3at 80°C, 90°C and 100°C,

respectively. These results showed that increased in solution temperature, increased density and proportion of water increased, density was decreased.

Variation in coating thickness of WPI coating

The results for coating thickness of Whey protein isolate coating with different proportion were recorded and presented in Table 2. The coating thickness of coating material was found to be 0.019, 0.021 and 0.024 mm for 40 + (30:30) ratio of Water + (WPI:Gly) coating composition at 80°C, 90°C and 100°C, respectively. For 50 + (25:25) ratio of Water + (WPI:Gly) coating composition, coating thickness was found to be 0.016, 0.019 and 0.022 mm at 80°C, 90°C and 100°C, respectively, whereas at 60 + (20:20) ratio of Water + (WPI:Gly) coating composition, coating thickness was found to be 0.015, 0.017 and 0.02 mm at 80°C, 90°C and 100°C, respectively. These results showed that as solution temperature increased, coating thickness was also increased and proportion of water increased, coating thickness was decreased.

The experimentation on measurement of different physical properties required for application of coating to the guava concluded that the 40 + (30:30) ratio of Water + (WPI:Gly) coating composition at 90°C was preferred for coating purpose. This concentration was the best suited for coating for prolongation of shelf life of guava.

CONCLUSION

During the experimentation of measuring physical properties of WPI based coating for shelf life extension of guava fruit, it was observed that properties like dimensions of fruits, viscosity, density and solution composition affect the thickness of coating and also shelf life of fruit. It was found that the coating thickness varied with viscosity, density and coating composition ratio of the solution.

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Table 1: Variation in length, width, thickness, size, volume and sphericity of guava fruit

Sr. No.	Length (l) mm	Width (b) mm	Thickness (h) mm	Size $D= (lbh)^{1/3}$ mm	Volume cm^3	Sphericity $\varepsilon= [(lbh)^{1/3}]/l$
1	56.77	67.22	67.16	63.25	143.7	0.94
2	56.89	64.18	62.94	61.00	120.5	0.95
3	56.35	57.13	57.05	56.61	98.2	0.99
4	59.13	62.48	61.99	60.93	125	0.97
5	60.95	63.67	63.56	62.45	131.5	0.98
6	61.72	65.73	64.33	63.63	132.7	0.96
7	58.95	61.75	59.75	59.89	114.4	0.96
8	60.98	62.89	62.47	61.85	129.7	0.98
9	58.22	61.13	60.51	59.69	112.7	0.97
10	55.34	59.88	58.68	57.69	109.2	0.96
Average	58.53	62.60	61.84	60.70	121.7	0.97
Range	55.34 to 61.72	57.13 to 67.22	57.05 to 67.16	56.61 to 63.63	98.2 to 143.7	0.94 to 0.99

Table 2: Variation in physical properties of whey protein isolate coating material

Coating Composition Water (%) + (WPI:GLY) (g:ml)	Solution Temperature (°C)	Viscosity (Pa.s)	Density (g/cm^3)	Coating Thickness (mm)
40+(30:30)	80	0.128	1.053	0.019
	90	0.173	1.062	0.021
	100	0.280	1.065	0.024
50+(25:25)	80	0.136	1.044	0.016
	90	0.157	1.05	0.019
	100	0.177	1.059	0.022
60+(20:20)	80	0.077	1.017	0.015
	90	0.087	1.021	0.017
	100	0.100	1.034	0.02

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