

# Development of Aloe Vera Jelly for Diabetic Patients and Analysis of Its Physicochemical Properties

Rebeka Sultana, Rokeya Begum<sup>\*</sup>, Md. Nannur Rahman, Md. Rakibul Hasan, Md. Azizul Haque

Department of Food Technology and Nutritional Science, Mawlana Bhashani Science and Technology University, Santosh, Bangladesh

## Email address:

rokeya15@yahoo.com (R. Begum)

<sup>\*</sup>Corresponding author

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**Abstract:** An attempt has been made in the present study to develop aloe vera jelly with honey in a view using it as an anti-diabetic agent for its therapeutic properties. Different aloe vera jellies were prepared with different sweetening agents including honey, sugar and aspartame to make a comparison on the basis of nutrient content, bioactive compounds, organoleptic quality, syneresis and microbial stability. Prepared jellies were analyzed for physico-chemical properties, bio-active compound (total phenolic content, vitamin C, and antioxidant) and organoleptic properties. Among the three jellies aloe vera jelly with honey exerts better organoleptic properties, higher consumer acceptance, higher textural profile, highest amount of bio-active compounds (total phenolic content, vitamin C and antioxidant) and lowest syneresis. Thus formulation of aloe vera jelly with incorporation of honey increases the sensory attributes, textural profile and decrease syneresis followed by longer shelf life. Therefore, aloe vera jelly with honey could be recommended for large scale production of aloe vera jelly which can be promoted as an anti-diabetic agent due to hypoglycemic properties of aloe vera and honey.

**Keywords:** Aloe Vera Gel, Jelly, Antioxidant, Honey, Anti-diabetic, Syneresis

## 1. Introduction

Diabetes is a chronic disease marked by the higher level of blood glucose from defects in insulin production, insulin action or both [1]. It is among the top 10 causes of death in adults, and was estimated to have caused four million deaths globally in 2017 [2]. In 2017, global health expenditure on diabetes was estimated to be USD 727 billion [2]. Since 2000, the International Diabetes Federation (IDF) has reported the national, regional and global occurrence of diabetes. In 2009 it was estimated that 285 million people had diabetes (T1D and T2D combined) [3], increasing to 366 million in 2011 [4], 382 million in 2013 [5], 415 million in 2015 [6] and 425 million in 2017 [2]. These days great attention is being given to management of diabetes with medicinal plants along with dietary restriction. Today a great number of modern drugs are still derived from natural sources and 25% of all prescriptions contain one or more active ingredients from plants [7]. Aloe vera has marvelous medicinal properties. It

contains a plenty of bioactive components, enzyme, minerals and vitamins [8]. Aloe vera lowers blood glucose levels in diabetic patients. It also improves the responsiveness of the body tissues towards insulin, thereby making insulin more effective. This makes aloe vera extremely suitable for wide scale treatment to all diabetic conditions [9].

Nowadays, using recipes of traditional medicine, including the use of apicultural products (i.e., honey), the diabetic patients can maintain the normal level of insulin in the blood and also their overall health condition. Honey composition comprises more than 200 components, with fructose, glucose, and water as main substances. Fructose content of honey varies from 21 to 43% and the fructose/glucose ratio from 0.4 to 1.6 or even higher [10]. Although fructose is the sweetest naturally occurring sweetener, it has a glycemic index of 19, compared to glucose which has 100 or sucrose (refined sugar) with 60 [11]. There is evidence that fructose tends to lower blood glucose in animal models of diabetes [12, 13]. Mechanisms

involved in this process may include reduced rate of intestinal absorption [14], prolongation of gastric emptying time [15, 16], and reduced food intake [17, 18]. Fructose stimulates glucokinase in hepatocytes, which plays an important role in the uptake and storage of glucose as glycogen by the liver. Glucose on the other hand, which is present beside fructose in honey, enhances the absorption of fructose and promotes its hepatic actions through its enhanced delivery to the liver [19]. Aloe vera and honey has been regarded as one of the most beneficial natural and herbal remedy to combat diabetes due to having lots of active components. Attempt has been taken by the authors to develop aloe vera jelly containing honey in a view working as an anti-diabetic agent and a functional food for diabetic patients.

## 2. Materials and Methods

### 2.1. Raw Materials

Aloe vera leaves, honey, sugar (sucrose) and aspartame were procured from the local market. Other chemicals e.g. citric acid and pectin were collected from laboratory. The experiments were conducted in the Department of Food Technology and Nutritional Science, Mawlana Bhashani Science and Technology University, Tangail. Bangladesh.

### 2.2. Process of Aloe Vera Jelly Preparation

Clean and washed aloe vera was peeled and gel was extracted. Then filtration was done to get clear gel. The aloe vera jelly was prepared according to standard method. Three types of aloe vera jelly were prepared by three different type sweeteners, such as sugar, honey and aspartame. The aloe vera gel, sweetener and citric acid for each jelly were mixed and cooked and poured into a jelly bottle for further analysis. Pilot experiments were carried out to standardize the materials (sugar, honey and water) and method (cooking time) for jelly preparation.

### 2.3. Sensory Analysis

The sensory evaluation of prepared aloe vera jelly was carried out by a 20 member of panelist to judge the general appearance, color, flavor, texture, taste and overall acceptability of prepared jelly. Judgments were made through rating products on a nine point Hedonic Scale with corresponding descriptive terms ranging from 9 'like extremely' to 1 'dislike extremely' [20].

### 2.4. Texture Analysis

Jelly texture profile was analyzed by two bit compression test using texture analyzer (Food Texture Analyzer FRTS series) according to Koh *et al.* [21] with small modification in probe size. The prepared jelly was stored at 4°C for around 18 hours before this test was carried out. The jelly was equilibrated to room temperature before measurement. The jelly was deformed

by compression at a constant speed of 2.0 mm/s to a distance of 4 mm from the gel surface using a cylindrical probe having diameter of 6 mm. All measurements were carried out in twice.

### 2.5. Physicochemical Analysis

Total titratable acidity was determined by titration with 0.1N NaOH [22]. A standard pH meter (OHAUS- ST 3100) was used for the determination of pH. Syneresis of aloe vera jelly were done by using the method as described by Hassan *et al.* [23] 25ml of aloe vera jelly at 5°C was slowly transferred to 50ml capacity centrifuge tubes causing minimum disturbance to the coagulum and centrifuged at 3394 RPM in a centrifuge (Make-Remi, India) for 20 min. The quantity of water separated at the top of the coagulum inside centrifuge tubes was recorded as milliliters. The weight fraction of the supernatant liquid was used as index of jelly syneresis.

$$\text{Syneresis percentage} = \frac{\text{Total weight of separated liquid (g)}}{\text{Total weight of sample (g)}} \times 100$$

### 2.6. Determination of Total Phenolic Content

Total phenolic compound was determined by the method of Singleton and Rossi [24] using Folin-Ciocalteu reagent and by measuring the absorbance of sample extract at 765 nm against blank solution and expressed as gallic acid equivalent (mg GAE g<sup>-1</sup> dry weight).

### 2.7. Determination of Antioxidant Activities

The DPPH radical scavenging capacity of each sample was determined according to Miliauskas *et al.* [25] The mixture containing the DPPH (2, 2-diphenyl-picrylhydrazyl) turns from deep violet to a yellow solution. The higher the antioxidant activity the discoloration rate was faster. The absorption was measured using a spectrophotometer (MODEL: T60 U, S/N: 18-1650-01-1010 AC230V (50-60Hz 150W) at 515 nm which gives the per cent inhibition of the sample and the equation is;

$$\% \text{ Inhibition} = \frac{A - B}{A} \times 100$$

Where, A is the absorbance of pure DPPH in oxidized form and B is the absorbance of sample taken after 15 minutes of reaction with DPPH.

### 2.8. Microbiological Analysis

One gram (1g) of jelly sample was taken into a culture tube and dissolved with 9 mL of peptone water. Nutrient agar was used as the culture media for the determination of total plate count and incubated at 36°C for 48 hours. Colony counter was used for the enumeration of total plate count. Yeast count was determined by inoculating the sample on potato dextrose agar and incubated at 25°C for 5 days [26].

### 3. Results and Discussions

#### 3.1. Process Optimization for the Preparation of Aloe Vera Jelly Containing Honey for Diabetic Patient

Several experimental attempts have been made in order to optimize the final procedure of jelly making. It involves experiments with different concentration of different ingredients needed for jelly preparation. Finally the most optimized ingredients with optimal concentration have been used for jelly preparation.

#### 3.2. Characteristic of Raw Materials

The physicochemical properties of basic two ingredients of aloe vera jelly i.e. honey and aloe vera gel were observed.

Table 1. Chemical characteristic of raw materials.

Test	Honey	Aloe vera
pH	3.92 ± 0.06	4.65 ± 0.04
Moisture (%)	13.18 ± 0.02	96.89 ± 0.01
TSS	78	14
Ash (%)	0.14 ± 0.03	0.16 ± 0.11
Protein (%)	0.73 ± 0.05	0.23 ± 0.42
Vitamin-C (%)	2.74 ± 0.02	0.0134 ± 0.01

Table 2. Sensory evaluation of three types of jelly.

Sample	General appearance	Flavor	Color	Texture	Taste	Overall acceptability
Aloe vera jelly with honey	6.8	6.8	7.2	6.8	6	7.4
Aloe vera jelly with sugar	8	7.4	8	7.2	7.2	7.4
Aloe vera jelly with aspartame	7.4	6.8	6.8	7.2	6.8	6.4

Values are mean of twenty samples.

Aloe vera jelly prepared with honey exhibits better sensory scores regarding general appearance, flavor, color, texture and taste than the control sample. Precisely its overall acceptability is far better than the commercial brand and equal with aloe vera jelly prepared with sugar.

#### 3.4. Texture Profile Analysis

Among three aloe vera jelly samples jelly with aspartame was unable to measure texture parameter as its structure was broken down after refrigeration. The textural profile parameters namely hardness, cohesiveness, springiness, gumminess, and chewiness of aloe vera jelly are presented in Table 3. The values of textural parameter of two aloe vera jelly were different. The jelly with honey had the higher mean value for all textural parameters than jelly with sugar. So, the honey effects on firmness, springiness and cohesiveness of jelly.

Table 3. Texture profile analysis parameters of aloe vera jelly with honey and aloe vera jelly with sugar.

Texture Profile	Jelly with honey	Jelly with sugar
Hardness	4.138 × 10 <sup>3</sup> N/m <sup>2</sup>	2.546 × 10 <sup>3</sup> N/m <sup>2</sup>
Cohesiveness	0.8846	0.8374
Springiness	0.8162	0.7282
Gumminess	3.660 × 10 <sup>3</sup> N/m <sup>2</sup>	2.132 × 10 <sup>3</sup> N/m <sup>2</sup>

Test	Honey	Aloe vera
Acidity (%)	4.74 ± 0.65	0.6 ± 0.01
Antioxidant activity (%)	24.34 ± 0.05	53.047 ± 0.07
Total phenolic content (mg/g)	7.0 ± 0.31	1.97 ± 0.51

Means ± SD, calculated as percentage for aloe vera and honey analyzed individually in triplicate.

The moisture content of aloe vera was higher than honey. Importantly the antioxidant activity of aloe vera was more than double than that of honey, which is almost similar to the result reported by previous study Vidic *et al.* [27]. But the total phenolic content of honey and aloe vera found in this study was lower than the previous result reported by Vidic *et al.* [27].

#### 3.3. Sensory Evaluation

As shown in the Table 2, data indicated the difference in the value of sensory parameter of prepared jelly. The sensory parameter of aloe vera jelly with sugar and honey were compared with standard jelly purchased from market. By sensory evaluation we can determine the color, flavor and texture and overall acceptability. It was determined by 9-point Hedonic Scale. Table 2 shows the data of sensory evaluation.

Texture Profile	Jelly with honey	Jelly with sugar
Chewiness	2.988 × 10 <sup>3</sup> N/m <sup>2</sup>	1.552 × 10 <sup>3</sup> N/m <sup>2</sup>

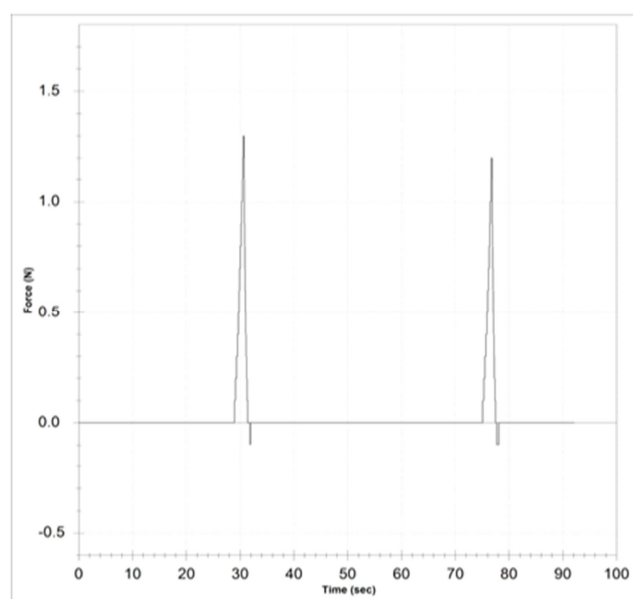


Figure 1. Texture profile of aloe vera jelly with honey.

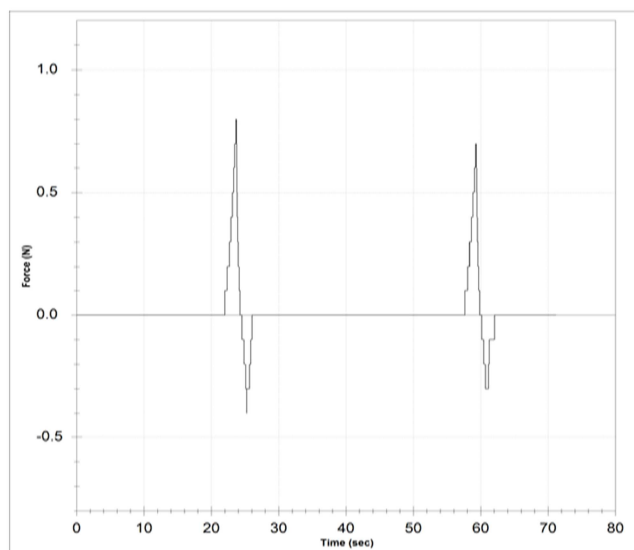


Figure 2. Texture profile of aloe vera jelly with sugar.

### 3.5. Syneresis

Syneresis is the contraction of a gel accompanied by the separating out of liquid. After laboratory tests the percentage of syneresis of aloe vera jelly with honey, aloe vera Jelly with sugar and aloe vera Jelly with aspartame is given accordingly  $7.93 \pm 1.56\%$ ,  $22.062 \pm 1.72\%$  and  $56.78 \pm 1.63\%$ . Jelly prepared with honey exhibited lowest percentage of syneresis and jelly with aspartame exhibited highest syneresis. Higher syneresis of aspartame added sample may causes growth of microorganism and spoilage of jelly.

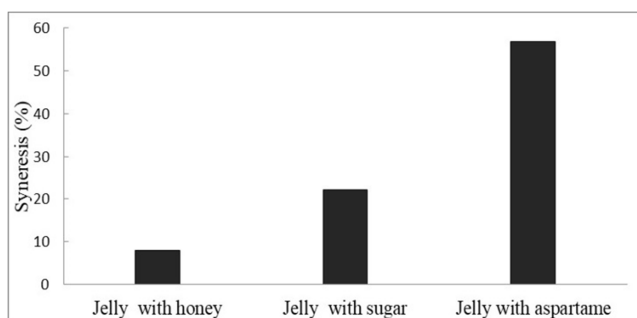


Figure 3. Syneresis percentage of aloe vera jelly.

### 3.6. Microbial Analysis

Figure 4 revealed the total viable count of bacteria and yeast colony in aloe vera jelly. After lab testing the amount of bacteria and yeast colony per gram of jelly made with aspartame was highest and jelly with honey was lowest value. The results indicate that the jelly with aspartame is more likely to contaminate by the microorganisms whereas jelly with honey has comparatively the least chance of contamination and spoilage by microorganisms. It also indicates the highest shelf life of jelly prepared with honey in comparison with two other whereas jelly with sugar indicates higher shelf life than jelly with aspartame but lower than jelly with honey.

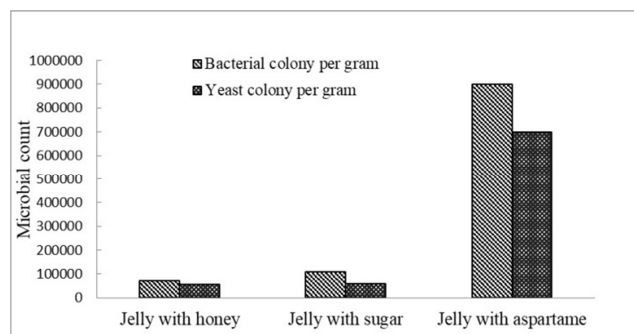


Figure 4. Microbial growth count during the 1<sup>st</sup> day of aloe vera jelly.

### 3.7. Chemical Composition of Jelly

Table 4. Chemical properties of aloe vera jelly.

Chemical properties	Jelly with honey	Jelly with sugar	Jelly with aspartame
Ash (%)	0.998 $\pm$ 0.01	0.997 $\pm$ 0.01	0.065 $\pm$ 0.01
Moisture (%)	43.35 $\pm$ 1.9	22.73 $\pm$ 0.49	56.35 $\pm$ 1.72
Vitamin-C (%)	0.165 $\pm$ 0.03	0.0115 $\pm$ 0.06	0.0064 $\pm$ 0.04
Antioxidant activity (%)	22.04 $\pm$ 1.56	21.933 $\pm$ 1.60	21.58 $\pm$ 1.50
Total phenolic content (mg/g)	0.7 $\pm$ 0.03	0.65 $\pm$ 0.02	0.57 $\pm$ 0.03
Acidity (%)	0.063 $\pm$ 0.01	0.053 $\pm$ 0.04	0.049 $\pm$ 0.01
pH	4.297 $\pm$ 0.01	3.293 $\pm$ 0.03	4.46 $\pm$ 0.04

Values are mean  $\pm$  SD.

The chemical properties of three different aloe vera jellies were different (Table 4). The moisture content of aloe vera jelly with aspartame was maximum whereas among three samples jelly with sugar contained lowest percentage of moisture ( $22.73 \pm 0.49$ ) and aloe vera jelly with honey contain slightly higher moisture than jelly with sugar ( $43.35 \pm 1.9$ ). Antioxidant activity and vitamin C content were highest in aloe vera jelly with honey ( $0.165 \pm 0.03$ ) and makes it more nutritious for consumption. Similarly the total phenolic content was highest in aloe vera jelly with honey ( $0.7 \pm 0.03$ ) in comparison with two others and obviously will render more health benefits. By laboratory test of pH it is evident that three types of jellies are acidic in nature. Among the three samples aloe vera jelly with honey showed better nutritional value and keeping quality.

## 4. Conclusion

Among different types of aloe vera jelly incorporated with various sweeteners, the more potential jelly to combat diabetes was put forward by analyzing different quality parameters (physico-chemical properties, bioactive compounds and organoleptic properties). Aloe vera jelly incorporated with honey had considerable effects on physicochemical and sensory properties of jelly. The comprehensive evaluation grade of aloe vera jelly with honey was excellent in terms of various quality attributes. Overall acceptability of aloe vera jelly with honey was comparatively better than other types. Similarly aloe vera jelly with honey had higher mean score in terms of textural parameters and lowest syneresis percentage than other types of jelly. Aloe

vera jelly with honey had highest amounts of vitamin C, antioxidant activity, total phenolic content which renders it more beneficial for diabetic patients. It may be concluded from the study that aloe vera jelly with honey may have higher potential to act as an anti-diabetic remedy besides other treatments. But further clinical experiments are required to make it surefire and identify the precise action of aloe vera jelly with honey in preventing diabetes.

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