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DEVELOPMENT AND PHYSICOCHEMICAL ANALYSIS OF WOOD APPLE JELLY CONTAINING IMMOBILIZED *LACTOBACILLUS ACIDOPHILUS*

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ABSTRACT

People nowadays prefer functional food products that have health benefits beyond their nutritional benefits. Fruit-based products with additional benefits of probiotics are also gaining popularity worldwide. This study aimed to develop and evaluate the physicochemical characteristics and sensory properties of wood apple jelly infused with probiotic microbes. Firstly, different solvent extracts of wood apple pulp were tested for total phenol, flavonoid, and antioxidant activities. Wood apple pulp and sugar were used to prepare control jelly (WAJ). The experimental jelly (PWAJ) was prepared similarly with addition of immobilized *L. acidophilus*. The pH, titratable acidity, colour, texture, total phenol, flavonoid, total antioxidant capacity and sensory characteristics of WAJ and PWAJ were analysed using standard methods. The methanolic extract of wood apple pulp showed significantly ($P<0.05$) higher total phenol, flavonoid, DPPH radical scavenging activity and ferric reducing antioxidant as compared to acetone and aqueous extract. There was no significant difference in pH, titratable acidity, colour, texture, total phenol, flavonoid, DPPH radical scavenging activity, or ferric reducing antioxidant capacity between WAJ and PWAJ. The sensory quality of both the jellies was stable during the storage period of one month except for flavour which was significantly reduced after 15 days. The probiotic count in PWAJ was 7.18 log CFU at zero day and did not change significantly up to 15 days. In conclusion, wood apple is a promising source of antioxidants. Incorporating probiotic organisms in wood apple jelly was found to be acceptable and can be used as a functional food.

Keywords: Wood apple, jelly, probiotics, antioxidant activity

INTRODUCTION

Functional foods provide health benefits beyond their macro and micronutrients **(Hasler, 2002)**. These health benefits are mainly attributed to the nutraceuticals like bioactive components dietary fiber, bioactive peptides, prebiotics, and probiotics. These compounds are beneficial for boosting immunity and preventing lifestyle diseases such as obesity, diabetes, hypertension, cancer, osteoporosis, stroke, and cardiovascular disease **(Gabay *et al.*, 2010)**. Fruits and vegetables are reported to possess antioxidants and dietary fibers, including different vitamins and minerals **(Singh *et al.*, 2016)**.

The wood apple (*Limmonia accidicema*) is one of the common names of edible fruit from several trees, mainly those belonging to the genus *Limmonia accidicema*. It is also known as elephant-apple, monkey fruit or crud fruit. It is commonly known as "kaitha" in India and "kotha" in Gujarati. It has a woody, extremely hard outer rind that is difficult to creak and open. Inner pulp is brown, mealy, aromatic, resinous, and sweetish with many small seeds **(Pandey *et al.*, 2014)**. The fruit pulp is used in preparations like jellies and jams, Syrups, and drinks **(Senthikumar and Venkatesau, 2013)**. The wood apple pulp is a rich source of Beta carotene, a significant amount of vitamins-B such as riboflavin and thiamine good amount of protein, dietary fiber, ascorbic acid, magnesium, calcium, and other minerals. It has various phytochemicals like alkaloids, saponins, flavonoids, and total phenols **(Kumar and Deen, 2017; Pandey *et al.*, 2014)**. Wood apple benefits against dysentery, diarrhoea, piles, and scurvy. It is reported as a tonic for the liver and heart and has protective effects against skin cancer **(Ahmed *et al.*, 2008)**. Among the conventional food preserves, jellies have been widely used, allowing the off-season consumption of fruits. Jelly is a gelatinous, semisolid product prepared with a mixture of fruit juice and sugar. Jelly is formed when pectin, sugar, acid, and water are in suitable concentration **(Codex Standard 296, 2010)**. Pectin is the most important substance that gives jelly proper structure and strength. Pectin is formed from a parent compound, protopectin, during fruit ripening. Wood apple pulp is rich in pectin (3-5%) and is an excellent material for preparing jelly **(Kumar and Deen, 2017)**.

Fruit-based products are becoming popular nowadays due to their health-promoting properties. These products may have better health benefits when incorporated with probiotic organisms. Fruit-based products with additional benefits of probiotics are gaining research interest such as probiotic yogurt with Annona pulp **(Senadeera *et al.*, 2018)**, antioxidant rich fruit supplemented probiotic yogurt **(Kumar *et al.*,2016)**, probiotic juice **(Shah *et al.*, 2016; Pandey, Naik *et al.*, 2015)**. Probiotics, especially lactic acid bacteria, have beneficial effects for gut health **(Raid, 2008)**, and treatment of intestinal disorders, inflammatory diseases, and allergies **(Parvez *et al.*, 2006)**. Antitoxin and diarrhoea reduction effects by dietary supplements of probiotics are proven to improve gut health and nutrient digestibility **(Balkrishnan and Floch, 2012)**. *Lactobacillus acidophilus* is a species of gram-positive bacteria. It is a homofermentative, microaerophilic species, fermenting sugar into lactic acid, and grows readily at low pH value (below pH 5.0). It possesses many health benefits such as reduced overgrowth of pathogens in human digestive tract, relieving irritable bowel syndrome and gut dysbiosis, treating respiratory infections like bronchitis and increased immune response **(Gomes *et al*, 1999)**. Extreme processing conditions can damage these cells. A few methods have been proposed to improve the viability of probiotics, out of which immobilization is reported as the most promising method **(Cai *et al.*, 2014; Sathyabama and Vijyabharti, 2014)**. Microencapsulation is an important technology that may be useful for the oral delivery of live probiotic bacteria (**Malmo *et al.*, 2013**). Microencapsulation of probiotics aims to protect the microorganisms from unfavorable conditions and enable the organism to arrive in the intestine in the required concentration that exhibits the beneficial effects **(Kailasapathy *et al.*, 2006)**. In this context, the present study is planned to analyse antioxidant activity of wood apple and to develop wood apple jelly containing immbolized *Lactobacillus acidophilus*.

MATERIALS AND METHODS

Procurement of raw material

The raw materials, namely wood apple (*Limmonia accidicema)* and sugar (Shree Renuka Sugar Ltd. Mumbai, India) for jelly preparation, were procured from the local market of Anand, Gujarat, India. All the materials were brought to the Food Biotechnology laboratory of the Post Graduate Department of Home Science, Sardar Patel University, Vallabh Vidyanagar, Gujarat.

Extraction of sample for antioxidant activity

2 gm of wood apple pulp was extracted using 25 ml of solvent. Three solvents were used: acidified methanol: water solvent (80:20) with pH 2.0, acetone (as such), and distilled water. The sample was extracted for 30 minutes in a shaker (Remi Ltd.) at room temperature, followed by centrifugation (Remi Sales and Engineering Ltd.,

Mumbai, India) for 10 minutes at 6000 rpm. The supernatant was collected, and the residues were extracted again with the respective solvent. The process was repeated three times, and the final volume of extracts was made to 100 ml. The extracts were stored in -20℃ till further use. The same extracts further analyzed total phenol, flavonoids, and antioxidant activity.

Total phenol estimation using Folin Ciocalteu method

Total phenol estimation was done by folin ciocalteu reagent method (**Singleton *et al.*, 1999**). An appropriate aliquot of extracts was treated with folin ciocalteu reagent (1:1) and 7.5% sodium carbonate. After incubation of 30 minutes at 37°C, the blue color developed in tubes was read at 750 nm in a spectrophotometer (Systronics Ltd.) against distilled water as blank. For standard, Gallic acid (5µg to 20µg) was used, and a result is expressed in mg GAE/100gm.

Determination of total flavonoid

The total flavonoid content was determined using a colorimetric assay **(Chang *et al.*, 2002)**. An appropriate sample aliquot was taken, treated with distilled water, and incubated for 5 minutes at 37°C. Then 5% sodium nitrite and 10% aluminum chloride were added and incubated for 6 minutes at 37°C. After incubation, 1 N sodium hydroxide was added. The developed pink color was read at 520 nm in a spectrophotometer (Systronics Ltd.). Rutin (50 µg to 200 µg was used as a standard and the results is expressed as Rutin equivalents (RE) mg/100g.

DPPH (2, 2-Diphenyl-1-picrylhy-drazyl) radical scavenging activity (DPPH RSA)

The DPPH RSA measures total antioxidant activity **(Benzie and Strain, 1999)**. An appropriate sample aliquot was mixed with DPPH reagent and incubated for 20 minutes at 37°C. Absorbance was read at 517 nm against methanol as blank in a spectrophotometer (Systronics Ltd.). As a standard, Trolox (5 µg to 20µg) and the result is expressed as Trolox equivalents (TE) in mg/100gm.

Ferric reducing antioxidant power (FRAP) assay

FRAP assay was done using the spectrophotometric method **(Brand Williams *et al.*, 1995)**. The appropriate sample aliquot was mixed with FRAP reagent, and tubes were incubated for 10 minutes at 37°C. The developed blue color complex was read at 593nm against distilled water as blank in a spectrophotometer (Systronics Ltd.). Trolox (0.5 µg to 2.0µg) was used as standard, and the result is expressed as Trolox equivalent (TE) in mg/100gm.

Immobilization of probiotic microorganisms

Lactobacillus acidophilus (LA-013) was used as probiotic strain, procured from National Collection of Dairy Cultures, NDRI, Karnal, India. The stock culture of *L. acidophilus* was activated in 100 ml MRS Broth and incubated at 37°C for 24 hrs. The culture was harvested after growth by centrifugation for 15 min at 7000 rpm, washed twice in phosphate buffer saline and then suspended in the same buffer. Optical density was adjusted to 1.00 at 600 nm with PBS (phosphate buffer saline) to obtain the desired cell concentration (10^6CFU/ml). It is mixed with a sterile solution of 2% sodium alginate solution (1:1). The uniform-size beads of this mixture were introduced into 4% sterile calcium chloride solution at room temperature and allowed it to stand for 30 min for complete gelation. Then the beads were washed with distilled water. They were transferred to a sterile solution of 0.4% calcium chloride and stored in a refrigerator (4°C) until further use. Approximate 135-140 beads (0.9 gram) were prepared from culture and sodium alginate solution (1:1).

Preparation of control and probiotic jelly

Control jelly (WAJ) was prepared from wood apple pulp. 100 gm of wood apple pulp was boiled in 150 ml of water for 10 minutes and the mixture was filtered. The filtered pulp was mixed with 75% of sugar and the mixture was heated with continuous stirring. The end point of cooking was judged by achieving 65º brix using a refractometer. The mixture was brought to a warm temperature, poured into a sterilized glass container, and allowed to set. The probiotic jelly (PWAJ) was prepared by the same method. Probiotic beads (approximate 0.9 gram) were added in PWAJ before pouring into to sterilized glass container. The developed WAJ and PWAJ were stored in a refrigerator (4°C) and were evaluated for physicochemical parameters, sensory attributes and microbial analysis.

Analysis of control (WAJ) and probiotic jelly (PWAJ)

Titratable acidity and pH

Titratable acidity of the jelly samples was analyzed by acid-base titration. The result was expressed as % citric acid. The pH of the control and probiotic jelly was determined using a digital pH meter (Systronics Ltd.).

Antioxidant activity

The jelly samples were extracted in the same way as extraction of wood apple pulp as mentioned above. The extracted samples were analyzed by total phenol, flavonoid, DPPH radical scavenging activity, and ferric reducing antioxidant power assay.

Color and texture analysis

Color measurement was done by hunter L, a, b color scale (Hunterlab Ltd.). The instrument was standardized, and the sample was transferred into a glass cup and read on the scale of L, a, and b.
Texture analysis was done by a texture analyzer (Brookfield Ltd.). For the evaluation of texture CT 3 probe was used. The compression test type was used with 10 mm target; 10 gm trigger load, and 1mm/s test speed. The hardness and stringiness were measured.

Microbial analysis

For microbial analysis, 5 gm of jelly was taken aseptically which was diluted to 45 ml of sodium citrate and then subjected to serial dilution with distilled water. Nutrient agar was used for total plate count, potato dextrose agar for yeast and mold count and MRS agar for *lactobacillus* count. The microbial analysis of jellies was carried out at regular intervals during storage.

Evaluation of sensory attributes

A composite score card was used for sensory evaluation of the jelly samples. Color, flavor, texture, taste, and overall acceptability were evaluated by semi-trained panel members. The same panel members evaluated the sensory attributes of jelly samples at regular intervals during storage.

Statistical analysis

The statistical analysis was done using SPSS (Version 20.0). All results are presented as mean and standard deviation. Student's t-test, ANOVA, and regression analysis was carried out.

RESULTS AND DISCUSSION

Antioxidant activity of wood apple

The result of total phenol, flavonoid, DPPH radical scavenging activity, and Ferric reducing antioxidant power of different extracts of wood apple is shown in table - 1. Methanol extract of wood apple showed the highest total phenol content (335.12 mg GAE/100gm), followed by acetone extract (98.93 mg GAE/100gm) and aqueous extract (76.25 mg GAE/100gm). A significant ($p<0.01$) difference was noted in total phenol content pertaining to the type of solvent used for extraction.
The principle of the colorimetric method is that aluminum chloride forms acid stable complexes with the C-4 keto group and either the C-3 or C-5 hydroxyl group of flavones and flavanols. In addition, aluminum chloride forms acid labile complexes with the orthodihydroxyl groups in A- or B-ring of flavonoids **(Chang *et al.*, 2002)**. In the present study, the potential of solvent for extracting of the flavonoid content of wood apple extract was observed in a pattern of methanol (mg RE/100g)>acetone (mg RE/100g)> distilled water (mg RE/100g).
Darshini *et al.* (2013) reported that the highest percentage of phenol and flavonoid was observed in methanolic extract while the lowest content was found in chloroform extract of wood apple. In another study, methanolic extract showed the best capacity to extract the highest antioxidant compounds from dessert bananas **(Ramlan *et al.*, 2017)**.
Moreover, the recovery of polyphenols from plant materials is influenced by the solubility of the phenolic compounds in the solvent used for the extraction process. Moreover, solvent polarity plays important role in increasing phenolic solubility **(Naczk & Shahidi, 2006)**.
The percentage of inhibition of DPPH within the assay time will reflect the antioxidant capacity of the extract assessed **(Gil *et al.*, 2000)**. A significantly higher DPPH-RSA was found in the methanolic extract (56.83 mg TE/100gm) than other solvent extracts.
The antioxidant capacity of fruit extracts is determined by the antioxidants' ability to reduce ferric iron to ferrous in FRAP reagent, which consists of 2, 4, 6-tris (1-pyridyl)-5-triazine (TPTZ) prepared in sodium acetate buffer, pH 3.6. The reduction of ferric iron in the FRAP reagent will form a blue product (ferrous – TPTZ complex) whose absorbance can be read at 593 nm **(Alothman *et al*, 2009)**. The highest FRAP was observed for the methanolic extract (684.94 mg TE/100gm) of wood apple, followed by acetone extract (134.3 mg TE/100gm) and aqueous extract (58.35mg TE/100 gm). A similar observation was reported by **Felhi (2017)**. Methanolic extracts of various parts of the plant like leaves, seeds, and peels showed the highest DPPH RSA and ferric reducing antioxidant power.
The extraction of phenolic compounds and their antioxidant activity is affected by many factors, namely the type of solvent used, the polarity of solvent **(Alothman**

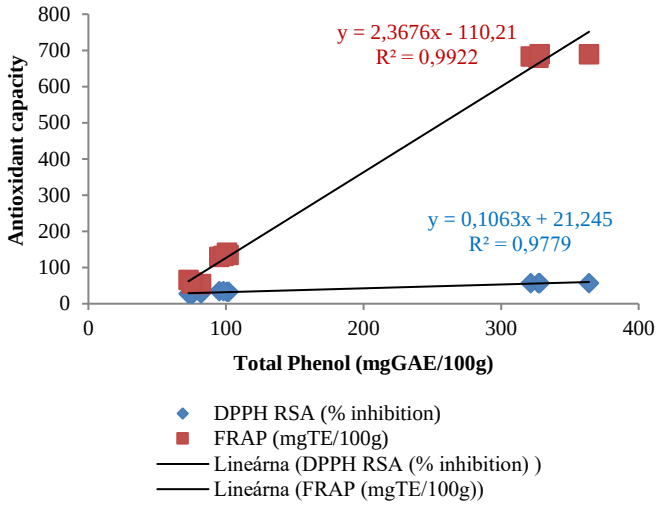
***et al.*, 2009)**, pH of solvent, plant material to solvent ratio, time and temperature of the extraction **(Robards, 2003; Dorta, 2013)**, the degree of polymerization of phenols and their interaction **(Djeridane *et al.*, 2006)**. For polar antioxidants, acetone: water mixture is proved to be a good solvent **(Lu and Foo, 1999; Luximon-Ramma *et al.*, 2003; Sun *et al.*, 2002)**. In comparison, organic solvents such as methanol and ethanol are mainly used to extract phenolics **(Antolovich *et al.*, 2000; Luthria and Mukhopadhyay, 2006)**.

A positive and significant (P<0.01) relation was observed between total phenols and DPPH radical scavenging activity (R^2=0.978, F=442.28, P=0.000) as well as total phenol and Ferric reducing antioxidant power (R^2=0.992, F=127.68, P=0.000) as shown in fig. 1-A. Similarly, a positive and significant(P<0.01) relationship was noticed between flavonoid and DPPH radical scavenging activity (R^2=0.967, F=292.85, P=0.000); flavonoid and Ferric reducing antioxidant power (R^2=0.939, F=155.60, P=0.000) as depicted in fig. 1-B. This reveals that antioxidant capacity of wood apple is attributed to total phenol and flavonoid content.

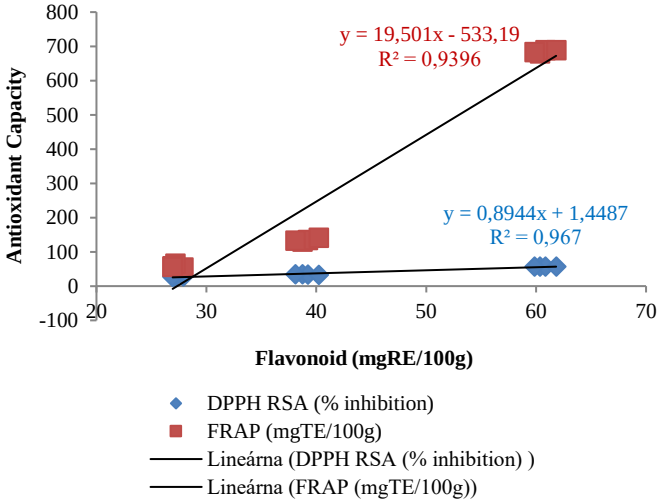
Table 1 Total phenol, flavonoid and antioxidant activity of different extracts of wood apple

Extract	Total phenol (mg GAE/100gm)	Flavonoid (mg RE/100gm)	DPPH radical scavenging activity (%inhibition)	Ferric reducing antioxidant power (mg TE/100gm)
Methanol	335.12^{c} ±19.12	60.72^{c} ±0.83	56.83^{c} ±0.16	684.94^{c} ±4.59
Acetone	98.93^{b} ±2.92	39.07^{b} ±0.88	33.49^{b}±1.00	134.3^{b} ±4.77
Distilled water	76.25^{a} ±3.91	27.23^{a} ±0.45	27.64^{a} ±0.581	58.35^{a} ±4.78

Values are mean ±SD of four observations, mean value with different superscripts within the column differ significant difference (p≤0.05)



A



B

Figure 1 Correlation of total phenol **(A)** and Flavonoid **(B)** with DPPH radical scavenging activity and ferric reducing antioxidant power of wood apple extracts

Physicochemical parameters of control (WAJ) and experimental jelly (PWAJ)

pH and Titratable acidity

The results of pH and titratable acidity of control (WAJ) and experimental jelly (PWAJ) are presented in table 2. No significant change (p>0.05) was observed in pH of WAJ during storage period. A similar trend was also observed for PWAJ. While comparing the pH of WAJ and PWAJ at regular storage intervals, no significant difference (p>0.05) was noticed. Titratable acidity of WAJ ranged from 2.36% to 2.5%. However, no significant change was observed during storage. Similarly, no significant change in titratable acidity was observed in experimental jelly during storage. Moreover, the titratable acidity of WAJ and PWAJ was not significantly varied at regular storage period.

Table 2 pH and Acidity of WAJ and PWAJ during storage

	Sample	0 Day	15 Day	30 Day	F-Value
pH	WAJ	3.70^{b}±0.15	3.30^{a}±0.26	3.70^{ab}±0.2	4.30^{NS}
	PWAJ	3.60^{a}±0.20	3.70^{a}±0.26	3.30^{a}±0.15	20.20^{NS}
Acidity	WAJ	2.36^{a}±0.40	2.42^{a}±0.10	2.5^{a}±0.1	0.217^{NS}
	PWAJ	2.64^{a}±0.12	2.5^{a}±0.17	2.51^{a}±0.05	0.801^{NS}

Values are mean ±SD of three observations; NS indicates no significant difference, mean value with different superscripts within a indicates a significant difference at p≤0.05, WAJ= Wood apple jelly, PWAJ= Probiotic wood apple jelly

As free probiotic bacteria are likely to have consumed carbohydrates and produced organic acids, the pH diminishes during storage. The microencapsulation of the probiotic bacteria was corroborated to provide stable protections for products over time **(Kailasapathy, 2006; Saarela *et al.*, 2006)**. Irrespective of bacterial strain, samples containing protected probiotics with sodium alginate have a more stable environment during storage (**Ding and Shah, 2008**).

Antioxidant capacity of WAJ and PWAJ

The result of total phenol, flavonoid and antioxidant capacity of WAJ and PWAJ is presented in Table 3. Total phenol content of WAJ (225 mg GAE/100gm) was significantly (p<0.05) higher than PWAJ (196 mg GAE/100gm). In contrast, the flavonoid content was significantly (P<0.01) higher in PWAJ (18.40 mg RE/100gm) as compared to WAJ (15.34 mg RE/100gm). Similar findings were observed for ferric reducing antioxidant power (FRAP). DPPH radical scavenging activity was significantly (p>0.05) higher in WAJ than in PWAJ.

Table 3 Total phenol, flavonoid and antioxidant activity of WAJ and PWAJ

Sample	Total phenol (mg GAE/100gm)	Flavonoid (mg RE/100gm)	DPPH radical scavenging activity (%inhibition)	Ferric reducing antioxidant power (mg TE/100gm)
WAJ	225.0* ±6.66	15.34* ±0.12	66.88* ±0.19	85.51* ±0.16
PWAJ	196.60 ±4.17	18.40 ±0.07	65.60 ±0.57	90.39 ±0.13

Values are mean ±SD of three observations, * indicates significant difference p≤0.05, WAJ= Wood apple jelly, PWAJ= Probiotic wood apple jelly

Colour score and texture of WAJ and PWAJ

Table 4 presents L, a, b value of control and experimental jelly. 'L' value indicates perceptual lightness of sample. 'a' value indicates axis was relative to green-red opponent colours and 'b' value indicates axis was represents the blue-yellow opponents' colours. About the colour scale L, a, and b, no significant (p>0.05) difference was observed between the jelly samples. It reveals that the addition of probiotic beads has no significant (p>0.05) change in the colour of the jelly. WAJ has a significantly (p<0.05) higher hardness (3130 gm) as compared to PWAJ (2777.50 gm). Similarly, the stringiness of WAJ (13.22mm) was significantly higher (6.82mm) than PWAJ.

Table 4 Colour score and Texture of WAJ and PWAJ

Sample	Colour score			Texture	
	L	a	b	Hardness (gm)	Stringiness
WAJ	9.35±0.47	3.32±0.02	0.44±0.02	3130.00*±150.0	13.22* ±0.38
PWAJ	9.33±0.18	3.33±0.03	0.36±0.02	2777.50 ±117.50	6.82 ±0.030

Values are mean ± SD of three observations, * indicates significant difference p≤0.05, WAJ= Wood apple jelly, PWAJ= Probiotic wood apple jelly

Sensory evaluation of WAJ and PWAJ

Table 5 shows the sensory evaluation of WAJ and PWAJ during storage. When comparing WAJ to PWAJ, no significant difference (p>0.05) was found in any of the sensory attributes. The colour of WAJ and PWAJ did not change substantially during storage. The texture, taste, and overall acceptance of jelly samples were found to be similar. The mean flavour score was considerably (p<0.05) reduced for both jelly samples during storage. The findings demonstrated that jelly infused with probiotic beads was well accepted and had good sensory stability throughout storage. **Talebzadeh *et al.* (2014)** also reported the jelly samples incorporated with microcapsules were well accepted pertaining to flavour, odour, colour, mouth texture while jelly samples incorporated with free bacterial was not well accepted by panel members.

Table 5 Mean score for sensory attributes of WAJ and PWAJ during storage

	Sample	0 Day	15 Day	30 Day
Colour	WAJ	8.33^{a} ±0.51	8.00^{a} ±0.5	7.66^{a} ±0.51
	PWAJ	8.16^{a} ±0.40	8.5^{b} ±0.54	7.83^{a} ±0.40
Flavour	WAJ	8.00^{a} ±0.00	7.5^{ab} ±0.5	7.33^{a} ±0.51
	PWAJ	8.00^{b} ±0.00	7.33^{a} ±0.51	7.83^{b} ±0.40
Texture	WAJ	7.50^{a} ±0.84	7.33^{a} ±0.82	7.17^{a} ±0.075
	PWAJ	7.50^{a} ±0.84	7.17^{a} ±0.98	7.33^{a} ±0.82
Taste	WAJ	7.00^{a}±0.00	7.5^{a} ±0.50	7.16^{a} ±0.40
	PWAJ	7.66^{a} ±0.51	7.66^{a} ±0.51	7.16^{a} ±0.40
Overall Acceptability	WAJ	7.50^{a} ±0.00	7.30^{a} ±0.40	7.40^{a} ±0.00
	PWAJ	7.50^{a} ±0.83	7.50^{a} ±0.83	7.50^{a} ±0.83

Values are mean±SD of six observations, mean value with different superscripts within a row indicates significant difference at p≤0.05, WAJ= Wood apple jelly, PWAJ= Probiotic wood apple jelly

Microbial analysis

It was observed that mean log CFU of probiotic wood apple jelly was 7.18 at zero day which was significantly (p<0.05) reduced to 6.29 on 15th day and further declined to 5.51 on 30th day of storage. It indicates experimental jelly in the present study possess probiotic properties up to 15th days as any food product that contain 10^{6}CFU/gm is considered as probiotic food product (Figure:5). **Talebzadeh *et al.* (2017)** also observed reduction in viable count while extending storage period. Microencapsulation technique helps in improving the stability of cells **(Lee *et al.*, 2004; Anal and Singh, 2007**) and sustain viability in harsh conditions such as high acidity and temperature **(Chandramouli *et al.*, 2004; Picot and Lacroix, 2004; Saarela *et al.*, 2006)**. No growth of other bacteria, yeast and mold was observed in both the jelly samples throughout the storage study period.

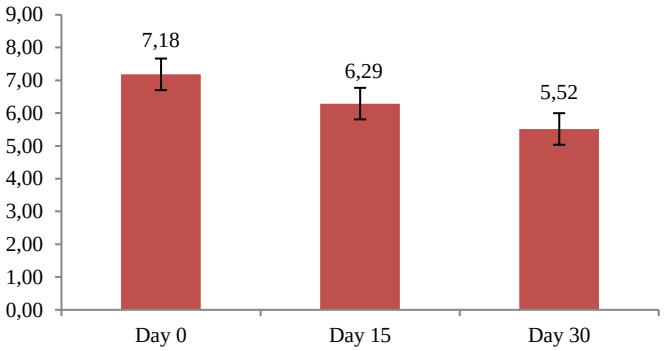


Figure 2 Mean value of log CFU probiotic of PWAJ (N=3)

CONCLUSION

In conclusion, methanolic extract of wood apple contained significantly higher content of total phenol, flavonoid, DPPH radical scavenging activity and ferric reducing antioxidant power. Wood apple jelly with the incorporation of immobilized probiotic organisms was well accepted pertaining to sensory attributes. The incorporation of probiotics did not affect pH, acidity, colour, texture, phenols, flavonoids and antioxidant activity of wood apple jelly. Experimental jelly sustained viability of probiotic organism up to 15th days upto 10^{6}CFU/gm. Hence, the incorporation of immobilized cells of probiotics is suggested for value addition in fruit jellies and wood apple jelly containing immobilized *Lactobacillus acidophilus* organisms that may be used as a potential functional food product.

Conflict of Interest

There is no conflict of interest concerning the research and authorship of this paper.

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