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Phytochemical properties of spray dried jamun juice powder as affected by encapsulating agents

Rakesh Kumar Raman, Swaminathan Santhalakshmy, Sowriappan John Don Bosco and Sangita Ganguly

Abstract
The aim of the present work is to investigate the phytochemical properties of Jamun fruit juice powder produced using three different carrier agents. Spray drying of the jamun juice powder was performed using a pilot scale spray dryer. Maltodextrin, gum Arabic and a combination of both maltodextrin/gum Arabic was used as a carrier agents. Optimization of the carrier agents was initially done based on the product yield. Powder samples were analysed for its phytochemical properties in terms of total anthocyanins, total phenols, total flavonoids to determine the best carrier agents retaining the functional properties of dried powder. The result reveals that the powder samples produced using gum arabic poses the best functional properties. Result obtained during the current investigation suggests gumarabic as a suitable carrier agents for production of jamun juice powder displaying its best inherent phytochemical attributes.

Keywords: Jamun fruit, spray drying, phytochemical properties, powder

1. Introduction
Phytochemicals are biologically active, naturally occurring chemical compounds found in plants, which protect plants from disease and damage and contribute to the plant's color, aroma and flavor. In general, the plant chemicals that protect plant cells from environmental hazards such as pollution, stress, drought, UV exposure and pathogenic attack are called as phytochemicals (Mathai, 2000) [14]. Phytochemicals are secondary plant metabolites having several biological properties such as antioxidant activity, antimicrobial effect, modulation of detoxification enzymes, stimulation of the immune system, decrease of platelet aggregation and modulation of hormone metabolism and anticancer property (Saxena *et al*., 2013) [19]. There are more than thousand known and many unknown phytochemicals. It is well-known that plants produce these chemicals to protect themselves, but recent researches demonstrate that they may protect human against several diseases (Rao, 2003) [16].
Jamun (*Syzygium cumini*) fruit popularly known as Indian blackberry is an underutilized fruit of Indian subcontinent and it belongs to *Myrtaceae* family. Jamun is of great significance among minor fruit of Indian origin, which is growing in various agro-climatic conditions (Aqil *et al*., 2012) [2]. This underutilized fruit is rich in phytoconstituents e.g. anthocyanins, flavonoids, steroids and phenolics etc. responsible for antioxidative properties (Banerjee *et al*., 2005; Baliga *et al*., 2011) [4. 3]. Traditionally, it has been used in the Indian folklore medicine system because of availability of these phytochemicals (Patel and Rao, 2012) [17].
Spray drying is one the widely and economical means of microencapsulation of thermal sensitive ingredients as core material receives lower heat which does not damage the components (Soottitantawat *et al*., 2003) [21]. Short residence time in combination with lower temperature confer spray drying operation suitable for heat sensitive food ingredients, like anthocyanins, as it promotes a higher flavor, color and nutrient retention (Masters, 1991) [13]. Various additives such as maltodextrin and gum arabic are used as drying adjunct to facilitate drying process as these carrier agents possess high solubility and low viscosity, an important consideration for spray drying operation (Quek *et al*., 2007) [18]. Limitations for the production of fruit juice powder using spray drying are stickiness, hygroscopicity, low solubility and degradation of bioactive components (Ferrari *et al*., 2012) [8]. Incorporation of carrier agents may safeguard the phytochemicals (anthocyanins) against unfavorable conditions like heat, light and oxygen, besides resulting in less hygroscopic powders (Tonon *et al*., 2010) [23].
There is a lack of studies regarding the phytochemical attributes of spray dried jamun fruit juice powder and have not been reported yet in literature. In this context, the present studies investigated the suitable carrier agents exhibiting the retention of best phytochemical attributes without compromising the powder properties.

2. Materials and Methods
2.1 Sample preparation and spray drying process
Fresh jamun (*Syzygium cumini*) fruits were purchased from a local market of Puducherry, India. It was processed into juice immediately without any further storage. Maltodextrin 20DE and gum acacia (Himedia, Mumbai) and blend (25, 15, 15:5% respectively) of both were added to the extracted juice as a carrier agent. The mixed solution was fed into a pilot-plant spray dryer.

Experiments were performed using a two- fluid nozzle pilot-plant spray dryer at a drying rate of 0.6 kg of water h^{-1} under various combinations of operating parameters. This is followed by two cyclone separators. Optimized conditions were used for the production of three different spray dried powder samples. Inlet temperature of 150, 155 and 145ºC for maltodextrin, gum arabic and the combination of both respectively, outlet temperature of 80, 85 and 85 ºC, carrier agent of 25, 10 and 15:5%, total soluble solids of 12, 14 and 18 ºBx, pressure of 0.8, 0.8 and 0.8 kg/cm^2 and feed flow rate of 12, 14 and 12rpm respectively. The highest powder yield was obtained by the sample produced by using maltodextrin as carrier agent i.e. 12.4%, whereas 9.7% yield by gum arabic sample and 11.5% yield by both the combination. The feed flow rate was controlled through the speed of the peristaltic pump. Feed flow rate was ranged from 10 to 16 RPM. Pressure was ranged from 0.4 to 1.6 kg/cm^2. The temperature of the feed mixture was maintained at 25ºC. Fig. 1 shows the process flow chart for the development of jamun juice powder. Dried powder samples were collected in the amber colored glass bottle at the base of the cyclone and stored in air-tight containers in a desiccator containing silica gel until further analysis. The produced samples were named/ labeled as MD, GA and C for the carrier agent maltodextrin, gum arabic and the combination of both the materials used as encapsulation agents and analysed for its phytochemical properties.

2.2 Analytical methods
2.2.1 Total Phenolic content (TPC)
Total phenols was determined using Folin-Ciocalteau reagent in alkaline medium and expressed as gallic acid equivalents conditions (Aqil *et al.*, 2012) [2]. Phenol content was calculated from the regression equations prepared from a range of concentrations of extract versus optical density for such concentrations and the regression equation prepared from different concentrations of gallic acid and optical densities for the concentrations.

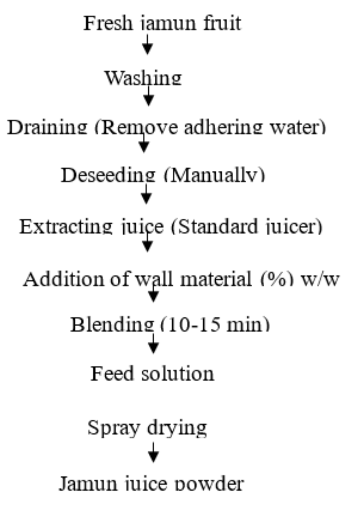

Fig 1: Process flow chart for the development of jamun juice powder

2.2.2 Total Flavonoid estimation
Total flavonoid content was estimated using Aluminium chloride technique suggested by (Benherlal and Arumughan, 2007) [5]. Briefly, 0.01g of catechin in 100 ml ethanol is used as stock solution from which standards is prepared using distilled water. 0.5 ml of sample for different concentrations of standards as 10µg/ml, 20µg/ml, 30µg/ml, 40µg/ml, 50µg/ml, 60 µg/ml, 70 µg/ml and so on is taken in different test tubes. All the test tubes are added with 0.1ml 10% HCl, 0.1 ml CH_3COOK and 2.8ml distilled water and are incubated at room temperature for 30 minutes. Absorbance at 415nm against reagent blank was measured.

2.2.3 Total Anthocyanin content
Anthocyanin content was determined using the pH-differential method (AOAC, 2006) and expressed as cyanidin-3-glucoside equivalent using molar extinction coefficient of 26,900 L cm^{-1} mol^{-1} and molecular mass of 449.2 g mol^{-1}. Concisely, 0.2-ml samples containing different concentrations of extracts were mixed separately with 0.8 ml each of 0.025 M potassium chloride, pH 1.0 (adjusted with HCl), and 0.4 M sodium acetate, pH 4.5. The reaction mixtures were allowed to equilibrate at room temperature for 15 min and absorbance was measured at 510 and 700 nm. The difference in absorbance between the two samples was then calculated using the formula:

$$\text{Absorbance (A)} = (A\ 510 - A\ 700)_{pH1.0} - (A\ 510 - A\ 700)_{pH4.5}$$

Finally, total anthocyanin in the samples were calculated by the following formula:

$$\text{Total anthocyanins} = [\text{Absorbance (A)} \times 449\ g\ mol^{-1} \times \text{dil factor}]/26,900\ L\ cm^{-1} mol^{-1}.$$

2.3 Statistical interpretation of the data
The experiments were carried out in triplicate and the data were analyzed statistically using SPSS software (SPSS PASW 20.0). The significance of difference between treatments was tested by analysis of variance (ANOVA) with Duncan's post hoc test at 5% level of significance. All the data were presented as the means and standard deviation.

3. Result and discussion
3.1 Functional Properties (Phytochemical properties)
3.1.1 Total Phenol Content (TPC)
Color of the fruits are strongly manifested by its phenolic contents. Besides these attributes, polyphenols having good antioxidative properties and demonstrated to act as antioxidants and assumed to exert various health beneficial effect for humans (Tomas & Robins, 1997) [22]. Total phenol content (TPC) was estimated and depicted in Fig.2. Optimized powder with GA had comparatively higher (54.2 mg GAE/g) TPC than other samples, i.e. 25.6, 33.8 mg GAE/g for MD & C respectively, whereas in fresh juice had TPC of 38.27 mg GAE /ml. Phenolic content retained in powders containing all the three carrier agents. But GA showed a significantly (P< 0.05) higher TPC as the glycoprotein make up of gum arabic provided protection to the phenols during thermal processing and contribution of natural phenols from the gums. Almost 33 percent of phenols were lost during thermal processing in case of powder produced using maltodextrin as a carrier agent. TPC evaluated in few jamun based products like wine (Chowdhury and Ray 2007) [7] and milk kulfi (Sonawane *et al.*, 2013) [20] and reported (GAE) values as 1.7 mg/100 ml wb and 1.74mg/g db. In comparison to these values all the powder samples had a higher TPC content. Thus, the product developed in the present study can be considered superior as

compared to the existing jamun based products in terms of TPC content.

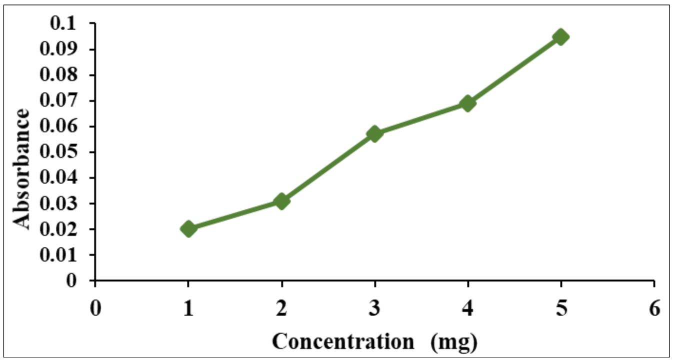

Fig 2: Gallic acid standard curve

3.1.2 Total Flavonoid

Flavonoid compounds are proven for their antioxidant activity and are reported to possess strong free radical scavenging activities based on their ability to act as or electron donors and chelate transition metals (Huyut *et al.*, 2017) [10]. Major flavonoids in jamun fruits are quercetin, kaempferol and myricetin reported to have anticancer, antiaging, anti neurological, neuro-protective, anti-inflammatory, antidiabetic and anti-analgesic effect together with having antimicrobial activities against Gram negative and Gram positive bacteria (Chhikara *et al.*, 2018) [6]. Flavonoid content in powder samples ranged from 11.83 to 47µg/mg as determined using catechin standard curve (Fig.3.). The total flavanoid content for the powder with MD was found to be least among all i.e. (11.83 µg/mg) whereas highest flavanoid content was estimated in powder having gum arabic i.e 47.00µg/mg. The flavonoid content of Jamun fruit was 19.67 µg/mg. Variations in flavonoid level might be due to different morphologies in the formation of encapsulated powder such as mononuclear capsule and aggregate in the spray drying process which had attribute to the variation in between the samples dried with different drying agents leading to enhancement of flavonoid content as compared to juice. Higher flavonoid in powder with GA may be due to the contribution of natural components of gum arabic. Similar trend can be observed in case of TPC and Total flavonoids. These results indicated that a higher flavonoid content was associated with a higher total phenolic content of the juice which is in agreement with the result reported for spray dried *Beta vulgaris* L and *Morinda citrifolia* L (Krishnaiah *et al.*, 2012) [11].

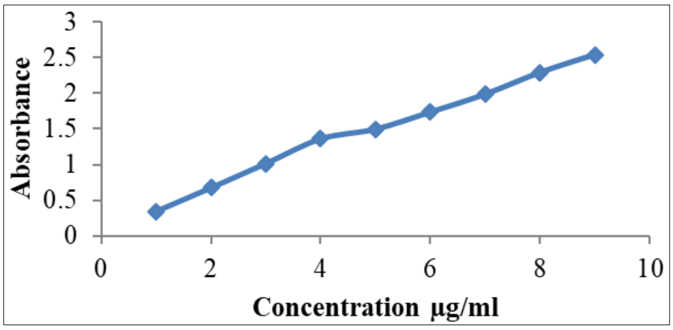

Fig 3: Catechin Standard curve

3.1.3 Total Anthocyanin Content (TAC)

Anthocyanins are glycosides of anthocyanidins and sugars represents a group of widespread natural phenolic compounds in plants, and are responsible for colours (Mazza and Miniati, 1993) [15]. Total anthocyanins contents of powders were expressed in terms of mg/100g.The results are represented in Table 1. Among the powders, GA contained the highest anthocyanin content followed by C and MD whereas for juice it was highest i.e. 140 mg/100gm. Post drying, decrease in the TAC content occurred due to thermal degradation of some anthocyanins. Heat induced TAC degradation was also reported by several workers (Garcia *et al.* 1998) during jam making which showed loss of about 17%–40% of anthocyanins. Although, the anthocyanins breakdown products formed during drying process might acts as antioxidants without being affected by the thermal process (Lohachoompol *et al.*, 2004) [12].

Table 1: Phytochemical attributes of spray dried jamun powder using various additives

Properties	JJ	MD	GA	C
Total Phenolic content (mg GAE/gm)	38.27±0.05	25.6±0.178^{c}	54.2±0.114^{a}	33.8±0.104^{b}
Total Flavonoid Content µg/gm	19.67±0.05	11.83±0.001^{c}	47.0±0.00^{a}	24.66±0.024^{b}
Total Anthocyanins mg/100g	140	70±0.01^{c}	86±0.07^{a}	69±0.006^{b}

4. Conclusion

Spray drying is an economical method for producing dry powders. It is a useful method for increasing shelf-life and stability of colorant which helps in easy handling by reducing volume. The use of short residence time and low temperatures makes spray drying a suitable mean for heat sensitive bioactive food components, such as anthocyanins found in jamun fruit. Results showed a significant difference in the phytochemical properties including total anthocyanins, total phenolic content and total flavonoid content in several samples. Among three samples, sample produced with gumarabic gave good results for all the phytochemical properties due to its inherent chemical composition and providing better protection to bioactives during drying process. The results indicated that good quality powders with improved functional properties in terms of phytoconstituent content can be produced by spray drying using Gum Arabic, which represents a great potential for application of such bioactive powders in food industry.

5. Acknowledgement

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6. References

1. AOAC. Official Methods of Analysis of the Association of Official Analytical Chemists, 18th edn. Gaithersburg, MD: Association of Official Analytical Chemists. (AOAC) International, 2006.
2. Aqil F, Gupta A, Munagala R, Jeyabalan J, Kausar H, Sharma RJ *et al.* Antioxidant and Antiproliferative Activities of Anthocyanin/ Ellagitannin - Enriched Extracts from *Syzygium cumini* L. (Jamun, the Indian Blackberry). Nutrition and Cancer. 2012; 64(3):428-438.
3. Baliga MS, Bhat HP, Baliga BRV, Wilson R, Palatty PL. Phytochemistry, traditional uses and pharmacology of *Eugenia jambolana* Lam. (black plum): A review. Food Research International. 2011; 44(7):1776-1789.

4. Banerjee A, Dasgupta N, De B. *In vitro* study of antioxidant activity of *Syzygium cumini* fruit. Food Chemistry. 2005; 90(4):727-733.
5. Benherlal PS, Arumughan C. Chemical composition and *in vitro* antioxidant studies on *Syzygium cumini* fruit. Journal of the Science of Food and Agriculture. 2007; 87(14):2560-2569.
6. Chhikara N, Kaur R, Jaglan S, Sharma P, Gat Y, Panghal A. Bioactive compounds and pharmacological and food applications of *Syzygium cumini*–a review. Food & function. 2018; 9(12):6096-6115.
7. Chowdhury PRCR, Ray RC. Fermentation of Jamun (*Syzgium cumini* L.) fruits to form red wine. ASEAN Food Journal. 2007; 14(1):15.
8. Ferrari CC, Germer SPM, Alvim ID, Vissotto FZ, De Aguirre JM. Influence of carrier agents on the physicochemical properties of blackberry powder produced by spray drying. International Journal of Food Science and Technology. 2012; 47:1237-1245.
9. Garcia-Viguera C, Zafrilla P, Artés F, Romero F, Abellan P, Tomás-Barberan FA. Colour and anthocyanin stability of red raspberry jam. Journal of the Science of Food and Agriculture. 1998; 78(4):565-573.
10. Huyut Z, Beydemir Ş, Gulçin I. Antioxidant and antiradical properties of selected flavonoids and phenolic compounds. Biochemistry research international, 2017, 309-311.
11. Krishnaiah D, Hiaw KB, Sarbatly R, Anisuzzaman SM, Nithyanandam R. Spray drying of *Morinda citrifolia* L. and *Beta vulgaris* L. fruit extract and its synergistic effect. International Journal of Chemical Engineering and Applications. 2012; 3(6):380.
12. Lohachoompol V, Srzednicki G, Craske J. The change of total anthocyanins in blueberries and their antioxidant effect after drying and freezing. BioMed Research International. 2004; (5):248-252.
13. Masters K. The spray drying handbook. New York: Longman Scientific and Technical, 1991.
14. Mathai K. Nutrition in the Adult Years. In Krause's Food, Nutrition, and Diet Therapy, 10th ed., ed. L.K. Mahan and S. Escott-Stump. 2000; 271:274-275.
15. Mazza G, Miniati E. Anthocyanins in fruits, vegetables, and grains, CRC Press Inc, United States of America, 1993, 1-28.
16. Narasinga Rao. Bioactive phytochemicals in Indian foods and their potential in health promotion and disease prevention. Asia Pacific Journal of Clinical Nutrition. 2003; 12(1):9-22
17. Patel PR, Rao TVR. Antibacterial activity of underutilized fruits of jamun (*Syzygium cumini* L. Skeels). International Journal of Current Pharmaceutical Research. 2012; 4(1):36-39.
18. Quek SY, Chok NK, Swedlund P. The physicochemical properties of spray-dried watermelon powders. Chemical Engineering and Processing: Process Intensification. 2007; 46(5):386-392.
19. Saxena M, Saxena J, Nema R, Singh D, Gupta A. Phytochemistry of Medicinal Plants. Journal of Pharmacognosy and Phytochemistry. 2013; 1(6):168-182.
20. Sonawane SK, Arya SS, Gaikwad S. Use of Jambhul powder in the development of bioactive components enriched milk kulfi. Journal of Microbiology, Biotechnology and Food Sciences, 2019, 2440-2443.
21. Soottitantawat A, Yoshii H, Furuta T, Ohgawara M, Linko P. Microencapsulation by spray drying: influence of emulsion size on the retention of volatile compounds. Journal of Food Science. 2003; 68(7):2256-2262.
22. Tomas-Barberan FA, Robins RJ. Phytochemistry of fruit and vegetables. In International Symposium of Phytochemistry of Fruit and Vegetables (1995: Murcia, Spain). Clarendon Press, 1997.
23. Tonon RV, Brabet C, Hubinger MD. Anthocyanin stability and antioxidant activity of spray dried acai (Euterpe oleracea Mart.) juice powder produced with different carrier agents. Food Research International. 2010; 43(3):907-914.