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ECO-FRIENDLY PROCESSING OF *MOMORDICA CHARANTIA* L. BASED CHEMICAL FREE FUNCTIONALLY ENRICHED NECTAR AND EVALUATION OF ITS NUTRITIONAL PROFILE

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Abstract

The study was conducted to utilize functional attributes of *Momordica charantia* juice extract by mixing with papaya pulp for imparting yellow-orangecolour of its carotenoids and aonla juice with high Vitamin C to develop *Momordica charantia* blended functional nectar beverage without any preservative and synthetic food colorant. The ratio of 50 : 25 : 25 of bitter gourd juice extract, aonla juice and papaya pulp with best sensory scores on a nine-point hedonic scale was optimized for the processing of the blended beverage. Functional profile in terms of quality attributes such as reducing sugars (8.39%), DPPH activity (64.20%), total phenolics (41 mg/100 ml), carotenoids (0.58 mg/100 ml), and ascorbic acid (28.8 mg/100 ml) were recorded best in organic honey-based spiced blended nectar. However, charantin content (0.111 mg/100 ml) was found highest in plain bitter gourd beverage. Organoleptic scores and rich functional profile recorded during studies strongly indicated a positive perception of consumers and the need for commercialization.

Introduction

In the recent past, consumers have become more aware of the role of functional food in decreasing the prevalence of chronic diseases. The rise of functional foods in the market has made the word nutrition and pharma indistinct from each other (Khan *et al.* 2013). Therefore, the consumption and production of functional foods have gained the interest of consumers, food and nutraceutical industries (Bigliardiand Galati 2013). Today, the most active class of functional foods are beverages (Corbo *et al.* 2014). Further, vegetables and fruits are considered as an excellent means of delivering bioactive compounds. Thus, the beverage industry isfocusing on blending the nutritionally rich medicinal vegetables with fruit juices to improve the overall functional and flavor profile (Baldini *et al.* 2017).

Bitter gourd (*Momordica charantia* L.) a medicinal cucurbit belonging to Cucurbitaceae is an excellent means of delivering nutrients such as vitamins, essential amino acids, riboflavin, niacin, folic acid, and minerals (Sorifa 2018). Its juice possesses numerous therapeutic properties *viz.*, antidiabetic, antioxidant, laxative, blood purifier, and stimulant. Despite these nutritional and therapeutic properties, it is not generally used in the beverage industry due to its bitter taste (Sharma and Tandon 2015). To overcome this drawback, mixing with other fruit juices seems to be an impressive alternative. Another functionally enriched botanical for the preparation of functional beverages is Indian gooseberry or aonla (*Emblica officinalis* L.), belonging to the family Euphorbiaceae. The vitamin C concentration of 100g of fresh aonla fruit is between 470-680 mg which is equivalent to the vitamin C concentration in two oranges (Patra and Samal 2018). This fruit is a reserve of significant antioxidants and polyphenols. Further, to impart natural

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colour in processed beverages, it is suggested to utilize horticultural commodities rich in natural colour pigments. One such natural pigment is carotenoid which also acts as a food colorant (Sharma *et al.* 2019). Thus, the organoleptic attributes namely the colour of nectar was enhanced with the inclusion of papaya (*Carica papaya*) belonging to the family Caricaceae, considered as a good source of carotenoids.

Moreover, the acceptance of beverages by consumers is determined by the sweetening agent. Sugar is a natural carbohydrate and usually used to improve the taste of the products. However, regular consumption of sugar predisposes to various chronic diseases (Rippeand Angelopoulos, 2016). Another natural sweetener that can be used to impart sweetness is honey. Its composition contains approximately 80 percent of carbohydrates, 18 percent of water, 2.0 percent of vitamins, minerals (especially Zn, K), and amino acids (Asaduzzaman*et al.* 2015). Therefore, honey especially organic forest honey can be used as a substitute for sugar for improving the sensory and nutraceutical profile of the end product (Sreckovic *et al.* 2019). Further, spice extract as a functional ingredient is being used in many food products to enhance flavour and storage life due to the taste-enhancing and antimicrobial properties (Fritts *et al.* 2018). In this context, the present study was carried out to develop functional blended nectar beverage by utilizing bitter gourd along with aonla, papaya, forest honey, spice extract, and subsequently compares the functional and sensory profile of the prepared nectar.

Materials and Methods

Fresh bitter gourd (*Momordica charantia*) cv Pusa hybrid I, aonla (*Emblica officinalis*) cv Desi, and ripe papaya (Carica papaya) cv Red Lady were procured from the local market. Other ingredients for the preparation of nectar such as organic forest honey, sulphur free sugar and spices *viz.*, cumin, black pepper, cardamom, common salt, and black salt were purchased from the local market. All the reagents and chemicals used in the study were of analytical grade.

Fresh and tender bitter gourds were sorted, washed, and cut into small pieces. The juice was extracted bypassing the cut pieces through a crusher-type juice extractor. Fresh and mature fruits of aonla were sorted, washed, sliced into small pieces, and destoned manually. The juice was extracted by using screw-type juice extractor. Ripened fruits of papaya were washed, peeled, and cut into two halves and pulp was extracted through domestic mixer grinder (Bajaj GX1).Spice extract was prepared by boiling a ground mixture of predetermined quantities of spices as per the standard recipe described by Anju *et al.* (2017) with slight modifications.

Different combinations of bitter gourd juice, aonla juice and papaya pulp with varying proportions of fruit part (blended juice) and total soluble solids (TSS) were tried for optimization of the recipe to prepare functional nectar as per the standard method. Various combinations of the blend of bitter gourd juice, aonla juice, and papaya pulp *viz.*, BT0 (B100 : A0:P0), BT1 (B90: A5 : P5), BT2 (B80 : A10 : P10), BT3 (B70 : A15 : P15), BT4 (B60: A20:P20) and BT5 (B50 : A25 : P25) were tried to prepare functional nectar with 20 percent juice, 15 °B TSS and 0.3-0.5 percent acidity as per the Food Safety and Standards Authority of India(FSSAI) specifications. Further, the selected blend was used to optimize the blended juice part and TSS to develop the best nectar in terms of organoleptic attributes. The best combination of blended juice was used to prepare different samples of nectar using sweeteners such as organic forest honey and table sugar. The samples viz., S0, S1, S2 and S3were prepared as per the standard procedure described by Ahmed *et al.* (2016).

The ascorbic acid, reducing and total sugars and carotenoid content were quantified as per the standard procedure illustrated in Ranganna (2017).The total phenolic content of the samples was estimated by the modified Folin-Ciocalteu method using catechol as a Singleton and Rossi's standard Procedure mentioned by Ranganna (2017). The results were expressed as mg per 100 g/ml on a fresh weight/volume basis.The determination of the antioxidant activity of different samples was done by 2, 2-diphenyl-2-picryl hydrazine (DPPH) inhibition method (Brand-Williams *et al.*1995) illustrated in Ranganna (2017). The reducing potential of the juice was evaluated by the procedure illustrated by Manohar (2017). The charantin is isolated from bitter gourd fruit and measured by the high-performance thin-layer method of chromatography procedure (Thomas *et al*. 2012).

The sensory attributes were examined by creating a panel of 15 judges who marked scores on a nine-point hedonic scale as described by Ranganna (2017).

Statistical analysis of quantitative data recorded on physico-chemical parameters was performed with the help of factorial Completely Randomized Design (CRD) analysis. Whereas the data pertaining to the organoleptic evaluation of the samples were done by Randomized Block Design (RBD) using two-factorial analysis of variance (ANOVA) with the help of OPSTAT (Sharma and Thakur 2016).

Results and Discussion

Data pertaining to chemical characteristics of extracted juice/pulp from bitter gourd, aonla, and papaya are presented in Table 1. The revealed that aonla juice contains significantly higher ascorbic acid content (511.48 mg/l) in comparison to bitter gourd juice (87.51 mg/100 g) and papaya pulp (51 mg/100 g). This difference also reflected a positive impact on the ascorbic acid content of blended beverages after processing. The total sugar (8.74%) and reducing sugar (5.29%) content of papaya pulp was the highest followed by aonla and bitter gourd juice. In the present study, aonla juice exhibited a maximum amount of phenolics (289.00 mg/100 g) followed by papaya pulp (133 mg/100 g). Similarly, Kumari and Khatkar (2016) recorded a rich phenolic profile of aonla fruits. Whereas bitter gourd juice had minimum (24.16 mg/100 g) phenols in it.

Table 1. Chemical attributes of fresh bitter gourd juice, aonla juice and papaya pulp.

Parameters	Mean± SE		
	Bitter gourd	Aonla	Papaya
Ascorbic acid (mg/100g)	87.51 ± 1.24	511.48 ± 14.82	51.00 ± 8.2
Reducing sugars (%)	0.58 ± .06	4.26 ± 0.19	5.29 ± 0.29
Total sugars (%)	1.84 ± 0.07	6.10 ± 0.16	8.74 ± 0.16
Antioxidant potential, DPPH (%)	68.84 ± 2.34	89.69 ± 0.85	73.85 ± 4.63
Total phenols (mg/100g)	24.16 ± 0.49	289.00 ±15.33	133 ± 8.83
Carotenoids (mg/100g)	1.05 ± 0.2	0.005 ± 0.02	4.92 ± 0.3
Charantin (mg/100g)	0.361 ± 0.2	-	-

Every value is mean of 3 replications; SE= Standard Error.

Due to the highest content of ascorbic acid and phenols, aonla juice was also recorded with a rich amount of antioxidant activity (89.69%) in comparison to other two juices. Moderately significantly higher concentration of carotenoids was observed in papaya pulp (4.92 mg/100 ml) than aonla juice (1.05 mg/100 ml), whereas a trace amount of this pigment (0.0005 mg/100 ml) was observed in bitter gourd juice. Charantin content, a phyto-chemical present only in bitter gourd responsible for its hypoglycemic behavior was found to be 0.391 mg/100 ml of the extracted juice. A similar trend of results was observed by Kim *et al.* (2014) while doing chemical analysis of different varieties of bitter gourd.

Results of organoleptic scores of blended juice percent prepared by using different proportions of bitter gourd juice, aonla juice, and papaya pulp are shown in Fig. 1 suggest that the nectar prepared by using treatment (BT5) with the blending ratio of B50 : A25 : P25 secured the highest organoleptic scores for colour, body, flavour, and overall acceptability (7.0, 7.5, 6.5 and 7.0) on the 9-point hedonic scale while treatment BT0 got the lowest. Thus, a treatment combination of BT5 (B50 : A25 : P25) was used for further preparation of different samples of nectar.

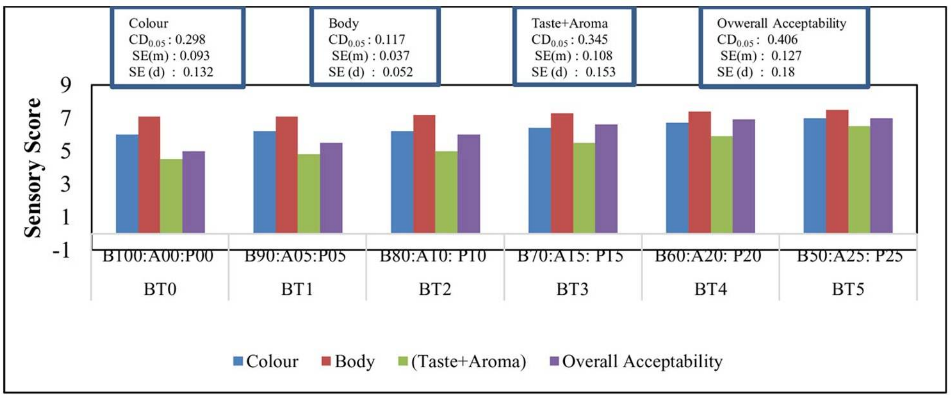

Fig. 1. Sensory evaluation of blends prepared by using different proportion of bitter gourd juice, aonla juice, and papaya pulp on 9-point hedonic scale.

S_0 = plain bitter gourd juice nectar as control, $S_{1 =}$ sugar-based non-spiced blended nectar, S_2= honey-based non-spiced blended nectar, $S_{3=}$ honey-based spiced blended nectar, B= Bitter gourd, A= Aonla, P= Papaya, CD=critical difference, SE (m)= standard error (mean), SE(d): standard error (deviation), BT= Blend

Data depicting results for the chemical attributes of different samples of nectars (S0, S1, S2 and S3) presented in Table 2 showed almost similar values were recorded for the total sugars with a range of 11.6 to 12.0% for all the prepared samples. However, when reducing sugars were estimated, honey-based blended nectars were found to be significantly higher for reducing sugars i.e. 8.33 and 8.39 % in treatment S2 and S3 whereas the corresponding values of 3.9 and 4.0 % were recorded in S1 and S0 for the same attribute. The significantly lesser reducing sugars of the sugar-based samples than honey might be because of the non-reducing nature of the table sugar in the form of sucrose, while honey mainly consists of glucose and fructose which come under reducing sugars as reported by Lakhanpal and Vaidya (2016).

The incorporation of aonla juice has improved the functional profile of the functional nectar as evident from higher ascorbic acid (28.8 mg/100 ml) and total phenolic content (41.00 mg/100 ml) of blended nectars compared to plain bitter gourd nectar (15.68 mg/100g and 5.43 mg/100ml), respectively (Table 2, Fig. 2). Among blended samples of nectar, honey-based blended nectars (S2 and S3) had more ascorbic acid than sugar-based blended nectars (S1 and S2) which might be because honey is a good source of vitamin C, unlike sugar which does not contain vitamins. However, no significant difference was observed between S3 and S2 (Table 3). Obtained results are more or less imilar to the results obtained by Khan *et al.* (2018). As for the total phenolic content, the highest mean value was observed in S3 (41 mg/100ml) followed by S2 (40 mg/100 ml), whereas, the minimal amount of phenols was seen in S0 (control). It was expected to observe a possible increase in this attribute in blended honey-based nectar due to the rich phenolic profile of forest honey. Further, mixing of spice extract might be the additional advantage to improve the overall phenolic content of S3 nectar. Baldini *et al.* (2017) observed a similar trend of increase in the resulting values of phenolics in apple nectar when supplemented with freeze-dried Araçá-boi.

Table 2. Quality attributes in terms of functional components of different samples of prepared nectars.

Parameters	Treatment samples (S)				$CD_{0.05,}$	SE(m), SE(d)
	S_0	S_1	S_2	S_3		
Reducing sugars (%)	2.89	3.90	8.33	8.39	0.256	0.077, 0.109
Total sugars (%)	13.70	13.50	13.00	13.11	0.561	0.169, 0.239
Ascorbic acid (mg/100ml)	14.95	23.00	28.15	28.80	1.045	0.316, 0.446
Total phenols (mg/100ml)	5.00	26.25	40.10	41.00	1.346	0.406, 0.575
Charantin (mg/100ml)	0.111	0.055	0.056	0.054	0.006	0.002, 0.002
Carotenoids (mg/100ml)	0.20	0.50	0.53	0.57	0.022	0.007, 0.009
Antioxidant activity, DPPH (%)	23.40	50.00	60.51	63.00	2.259	0.682, 0.965
Antioxidant activity, FRAP (mg/AA100ml)	2.73	5.84	6.21	6.36	0.245	0.074, 0.105

Every value is mean of 3 replications.

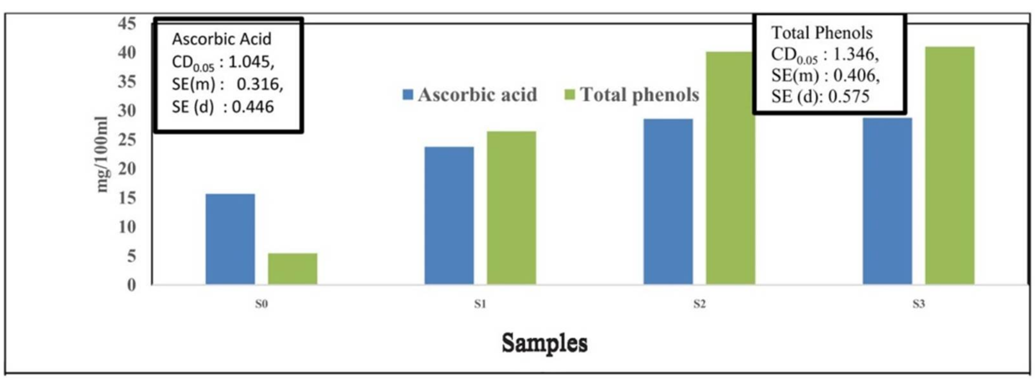

Fig. 2. Comparative concentration of ascorbic acid and total phenols content of prepared different blended nectar.

Resulting values illustrated in Fig. 3 and Table 2 depicts that the concentration of total carotenoids was significantly lower in plain bitter gourd nectar (0.20 mg/100 ml) than other blended samples of nectar *viz.,* S1 (0.50 mg/100 ml), S2 (0.53 mg/100 ml) and S3 (0.57 mg/100 ml). From the resulting values, it was also evident that higher carotenoid content in blended nectar might be because of the presence of ripe papaya pulp. No significant difference between the values obtained for sugar and honey-based blended beverages as the papaya pulp percent was the same in each blended formulation. A similar trend of results in terms of an increase in the concentration of carotenoids was noticed by Prabha *et al.* (2019). In the present study, charantin content was the highest (0.111 mg/100 ml) in plain bitter gourd beverage (S0) as compared to other blended samples (Fig. 3). This might be due to the decrease in the percent of bitter gourd juice after blending with aonla juice and papaya pulp.

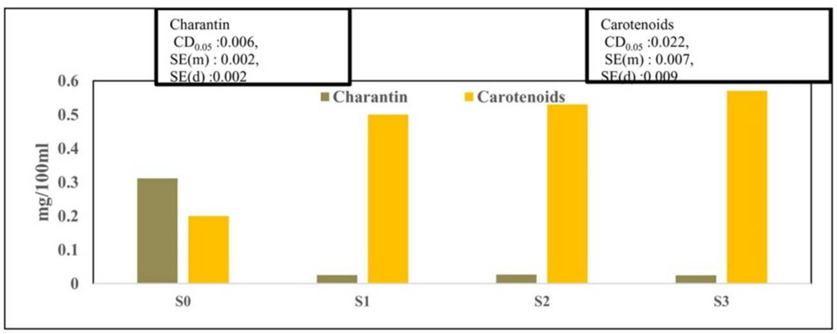

Fig. 3. Comparative evaluation of charantin, and carotenoid concentration of prepared different blended nectar.

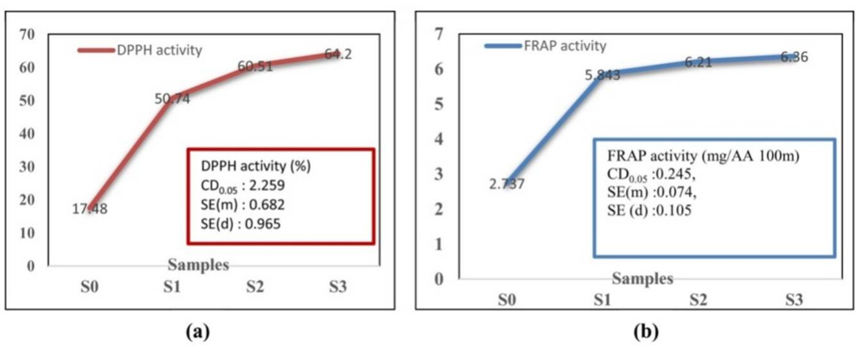

Fig. 4. Comparative evaluation of DPPH (a) and FRAP(b) activity of prepared different blended nectar.

Results obtained by the DPPH assay showed that S3 had the maximum antioxidant capacity (Fig. 4a). Significantly lower antioxidant capacities for the DPPH method were determined for S2 and S1. The lowest value was recorded for S0. This might be because phenolic compounds have the ability to donate their electrons or hydrogen ions, so they can also act as antioxidants. Thus, the addition of fruit extract (aonla and papaya) rich in phenols and organic acids contributes to the antioxidant capacity of the beverage. In addition, the incorporation of forest honey and spice extract, which have been reported with good free radical scavenging activity in research studies might have added to the antioxidant potential of the beverage.

Similarly, the FRAP assay was also performed to obtain a somewhat accurate estimation of antioxidant activity. The obtained values of nectar samples were found to range from 2.73-6.36 mg AA/100ml (Fig. 4b). The assay showed that S3 had the highest value of FRAP (6.86 mg/AA 100ml) followed by S2 and S1. As per expectations due to the low antioxidant activity of plain nectar, FRAP value was recorded lowest in S0. High FRAP value in the blended beverage samples might be due to the richness of aonla juice with ascorbic acid. In S3, additional forest honey and spice extract also contributed to the elevation in the FRAP value.

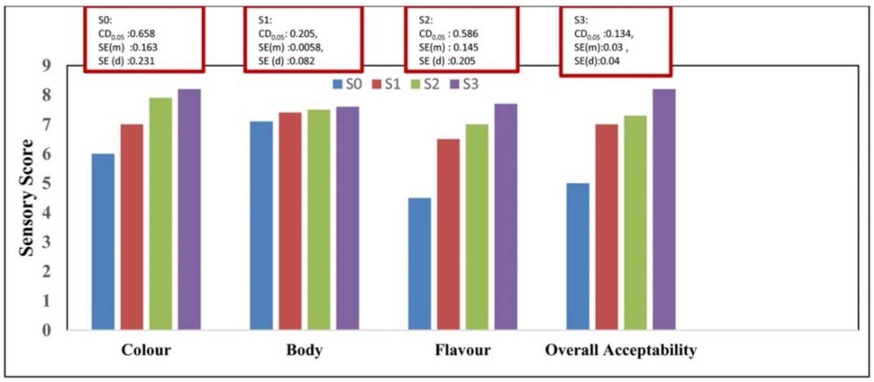

Fig. 5. Sensory scores of prepared different blended nectars on a 9-point hedonic scale.

Data on the sensory profile of different samples of nectar analyzed through a 9-point hedonic scale is shown in Fig. 5. From the data on colour rating, the highest mean score was recorded in S3 (8.2) followed by S2 (7.9), S1 (7.0), and S0 (6.0), respectively. Improved colour of honey-based beverage might be due to the presence of honey instead of sugar. Further, the darker color of honey reflects high antioxidant activity, biological value, and phenolic content (Pontis*et al.* 2014). Sugar lacks antioxidants and phenolic compounds, so sugar-based non-spiced nectar is comparatively less attractive in colour. For the determination of body scores in different samples of nectar, the highest score was observed in S3 (7.6) followed by S2 (7.5), S1 (7.4), and S0 (7.1), respectively. Further, concerning the flavour, the highest mean score is observed in S3 (7.7) followed by S2 (7.0), S1 (6.5), and S0 (4.5), respectively. The highest scores for flavour in spiced nectar might be due to the presence of honey and spice extract. The sweetening effect of honey was found to increases the flavour profile. Further, spice extract imparts a characteristic aromatic flavour to the nectar due to the presence of essential oils. The data on overall acceptability showed the highest average score in S3sample. Thus, concerning sensory impressions, the best scores among all the combinations were evident for spiced honey-based nectar.

In conclusion it may be said that S3 obtained the highest acceptability in terms of quality attributes. Also, it marks an impressive increase in organoleptic attributes suggesting its commercial potential in the beverage and functional food industry. Therefore, this investigation might represent the basis for the researcher's desire to enhance the functional profile of beverages by blending fruit and vegetable juices.

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References

Ahmad T, Raj D, Senapati AK, Tandel YN, TakMK and Kumar V 2016. Fruit nectar as a refreshing beverage an overall review. In press: J. Plant Dev. **8**(7): 321-328.

Asaduzzaman M, Rahman MS, Munira S, Rahman MM, Islam M, Hasan M, Siddique MAH, Biswas MS, Khan MH, Rahman M, and Islam MA 2015. Analysis of biochemical composition of honey and its anti-oxidant, Phytochemical and anti-bacterial properties. Inpress: J. Biomed. Pharm. Res. **4**(4): 69-81.

Anju K. Dhiman, G. Nagendra Babu, Attri Surekha and Ramchandran Preethi. 2017. Development and Standardization of Ripe Pumpkin Based Squash and its Stability during Storage. Int. J. Curr. Microbiol. App. Sci. **6**(10): 821-831.

Baldini TF, Neri-Numa IA, Do Sacramento CK, Schmiele M, Bolini HMA, Pastore GM, and Bicas JL 2017. Elaboration and characterization of apple nectars supplemented with Araçá-boi (*Eugenia stipitata* Mac Vaugh—Myrtaceae). In press: Beverages. **3**(4): 59.

Bigliardi B and Galati F 2013. Innovation trends in the food industry: The case of functional foods. In Press: Trends Food Sci. Technol. **31**(2):118-129.

Brand-Williams W, Cuvelier ME and Berset CLWT 1995. Use of a free radical method to evaluate antioxidant activity. In press: LWT-Food Sci. Technol. **28**(1): 25-30.

Corbo, MR, Bevilacqua A, Petruzzi L, Casanova FP and Sinigaglia M 2014. Functional beverages: the emerging side of functional foods: commercial trends, research, and health implications. In press: Compr. Rev. Food Sci. Food Saf. **13**(6): 1192-1206.

Fritts JR, Fort C, Corr AQ, Liang Q, Alla L, Cravener T, Hayes JE, Rolls BJ, D'Adamo, C and Keller KL 2018. Herbs and spices increase liking and preference for vegetables among rural high school students. In press: Food Qual Prefer. **68**:125-134.

Khan MA, Hashmi MS, Muhammad A, Muneeb M, Bilal H and Wali G 2018. Development and storage study of orange date blended squash. In press: Sarhad J. Agric. **34**(3): 509-515.

Khan RS, Grigor J, Winger R and Win A. 2013. Functional food product development–Opportunities and challenges for food manufacturers. In press: Trends Food Sci. Technol. **30**(1): 27-37.

Kim YK, Park WT, Uddin MR, Kim YB, Bae H, Kim HH, Park KW and Park SU 2014. Variation of charantin content in different bitter melon cultivars. In press: Asian J. Chem. **26**(1): 309.

Kumari P and Khatkar BS 2016. Assessment of total polyphenols, antioxidants and antimicrobial properties of aonla varieties. In press: J. Food Sci. Technol. **53**(7): 3093-3103.

Lakhanpal P and Vaidya D 2015. Development and evaluation of honey-based mango nectar. In press: J. Food Sci. Technol. **52**(3): 1730-1735.

Manohar C 2017. Antioxidant and antiproliferative activity of flavonoids from Ontario grown onions by pressurized low polarity water technology (Dissertation). The University of Guelph. p. 95.

Patra S and Samal P 2018. Aonla (*Emblica officinalis* G.): Nutritional and medicinal attributes. In press: Int. J. Agric. Sci. **10**(20): 7387-7389.

Pontis JA, Costa LAMAD, Silva SJRD and Flach A 2014. Color, phenolic and flavonoid content, and antioxidant activity of honey from Roraima, Brazil. In press: Food Sci. Technol, Campinas. **34**(1): 69-73.

Prabha A, Modgil R, Kaundal S and Sandal A 2019. Effect of blending and storage on the physicochemical composition of the papaya and mango squash. In press: Asian J. Dairy & Food Res. **38**(2): 150-154.

Ranganna S. 2017. Handbook of Analysis and Quality Control for Fruit and Vegetable Products. McGraw Hill Education Publishing. Seventh edition.

Rippe JM and Angelopoulos TJ 2016. Relationship between added sugars consumption and chronic disease risk factors: current understanding. In press: Nutrients. **8**(11): 697.

Sharma A and Thakur NS 2016. Influence of active packaging on quality attributes of dried wild pomegranate (*Punicagranatum* L.) arils during storage. In press: J. Appl. Nat. Sci. **8**(1): 398-404.

Sharma A, Dhiman AK, Mittal S, Attri S and Dubey N 2019. Carotenoid pigment: significance as a natural food colourant and factors affecting its isolation. In press: Int. J. Curr. Microbiol. App. Sci. **8**(2): 44-51.

Sharma R and Tandon D 2015. Development and evaluation of antioxidant rich low calorie functional bitter gourd (*Memordicacharantia* L) spiced squash. In press: Int. J. Farm Sci. 5(1): 68-77.

Sorifa AM 2018. Nutritional compositions, health promoting phyto-chemicals and value-added products of bitter gourd: a review. In press: Int. Food Res. J. **25**(5): 1-10.

Srećković NZ, MihailovićVB and Katanić-Stanković JS 2019. Physico-chemical, antioxidant and antimicrobial properties of three different types of honey from Central Serbia. In press: Kragujevac J. Sci. **41**: 53-68.

Thomas CT, Reddy PY and Devanna N 2012. Impact of cooking on charantin estimated from bitter melon fruits using high performance thin layer chromatography. In press: Int. Res. J. Pharm. **3**(6): 149-154.

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