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Influence of different hydrocolloids on dispersion of sweet basil seeds (*Ocimum basilicum*) in fruit-flavoured beverages

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ABSTRACT

Sweet basil seeds (*Ocimum basilicum)* are a rich source of dietary fiber. Considering the importance of dietary fiber on human health and the rising market demand for functional beverages, an attempt was made to develop fruit-flavoured beverages with basil seeds suspension. Different hydrocolloids like carrageenan, xanthan gum, gelatin and gum arabic were used at 0.02, 0.3, 1 and 2% w/v, respectively, to understand the stability of dispersed sweet basil seeds in fruit-flavoured beverages. The developed beverage samples were analyzed for colour (*L**, *a**, *b**), zeta potential (Z), viscosity and relevant organoleptic qualities. Results showed that beverage composition with xanthan gum had Z value of -34.1 mV and viscosity of 232.6 cP, provided better stability for the dispersion of basil seeds. The hydrocolloids gelatin and xanthan gum showed a slight variation in colour values. Beverages containing 0.3% w/v xanthan gum were found to be the best formulation for the production of fruit-flavoured beverages with uniformly suspended basil seeds.

Introduction

The global market for beverages is huge. However, increased consumption of soft drinks can lead to weight gain, obesity, diabetes and other health-related diseases. This necessitates development of beverages that can also offer health benefits. Functional drinks are a major subsector of the beverage market, gaining popularity due to their high nutritional and health benefits, which include drinks fortified with vitamins, minerals and nutraceuticals. The "foods and food components that provide a health benefit beyond basic nutrition" are called functional foods (Serafini et al., 2012). Among the available range of functional foods, beverages are preferred due to easy incorporation of desirable nutrients and improved shelf-life, with better sensory properties (Sanguansri and Augustin, 2009; Wootton-Beard and Ryan, 2011; Kausar et al., 2012). Most of these drinks are developed with specific health benefits or therapeutic value; including cardio protective and anticancer properties. They maintain intestinal microbiota, improve digestion and boost immunity (Tenge and Geiger, 2001). Higher consumption of fast food, carbonated beverages and lower intake of dietary fiber leads to negative health effects (NHMRC, 2006). At the moment, there is a rising demand for beverages with functional and sensory properties. Increased health concern of consumers demands fortification of foods with dietary fiber. Dietary fibers assist in controlling cholesterol levels in the body, diabetes, reducing weight, and also in preventing cardiovascular diseases, diverticulitis, varicose veins and colon cancer (Shahidi and Ambigaipalan, 2016). It is also a potent source of prebiotics that selectively modulates host microbiota and improves host

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health (Fallourd and Viscione, 2009). Generally, dietary fiber is classified as soluble and insoluble portions. While soluble fibers are mostly used in beverage fortification, incorporation of insoluble fibers in beverage and maintaining its dispensability is more difficult (Shahidi and Ambigaipalan, 2016).

Sweet basil seeds (*Ocimum basilicum)* have been used in ayurvedic medicines to improve blood circulation, anti-inflammatory, blood sugar control and also to improve immunity (Afifah and Gan, 2016). Basil seeds contain 10.0±0.46% protein, 33.0 ± 0.61% fat, and 43.9 ± 0.22% carbohydrates (Nazir et al, 2017). Due to their excellent nutritional properties and health benefits, they are used in Asian beverages and desserts like falooda (Azoma and Sakamoto 2003; Bucktowar et al., 2016). While basil seeds usage was limited due to the lack of popularity, in recent days these seeds gained attention and have been used in many ways due to the excellent health benefits they offer (Bucktowar et al., 2016). Moreover, very few studies have reported the incorporation of basil seeds in beverages (Behbahani and Abbasi 2017; Hajmohammadi et al., 2016).

Incorporation of dietary fibers into food products remains a challenge due to their negative effects on sensory qualities (Cui and Roberts, 2009). Beverages are the most suitable products to enrich dietary fibers, considering the potential of hydration of dietary fibers before ingestion (Dikeman and Fahey, 2006). Considering the potential health benefits of basil seeds, dispersion of basil seeds into beverages will be an ideal choice for dietary fiber supplementation. Hence, the objectives of this study were to develop fruit flavoured functional beverage infused with dietary fiber-rich basil seeds and to study the effects of different hydrocolloids on the dispersion stability of basil seeds and their organoleptic properties.

Material and methods

Materials

Basil seeds were purchased from a local market in Thanjavur, India. Xanthan gum (E415) and carrageenan (E407) were procured from Himedia, Mumbai, India; Gum Arabic (E414) was procured from Sigma Aldrich and gelatin was purchased from the local market. Lemon yellow (E102) and pineapple flavours of synthetic grade were purchased from Bush brand.

Preparation of beverage

Basil seeds were cleaned to remove impurities and 0.34% (w/v) of seeds were soaked in water for 20 minutes. After hydration, excess water was drained using a perforated material and the seeds were separated. Hydrocolloids at varied concentrations; like gum arabic (0.5 to 5% w/v), carrageenan (0.01 to 0.5% w/v), gelatin (0.5 to 2% w/v) and xanthan gum (0.1 to 0.5% w/v) were used considering mouth feel characteristics (Saha and Bhattacharya, 2010; Genovese and Lozano, 2001). Gum arabic and carrageenan above 0.2% and 0.02% w/v concentration, respectively, gave bitter taste to the beverage. Gelatin and xanthan gum form a soft gel consistency when added above 1% and 0.3% w/v concentrations, respectively. Based on preliminary studies and literature, optimal concentration for each hydrocolloid were fixed at 2%, 0.02%, 1% and 0.3% w/v for gum arabic (GA), carrageenan (CRG), gelatin (Ge) and xanthan gum (XG), respectively. Hydrated basil seeds were mixed in beverage containing lemon yellow (E102) and pineapple flavours; total soluble solids were maintained at 12 °Brix. Beverages were pasteurized at 80 °C for 5 minutes and representative samples were used for further analysis.

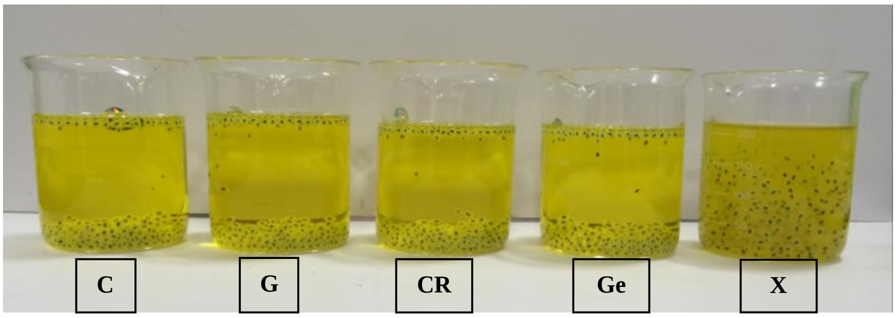

Fig. 1. Basil seed fruit-flavored beverage with different hydrocolloids. C-Control; GA- Gum Arabic; CRG- Carragennan; Ge-Gelatin; XG- Xanthan gum

CIE Colour values (L, a*, b*)*

CIE colour values (*L**, *a**, *b**) of basil seed incorporated fruit-flavored beverage were analyzed using Hunter colour lab model D_{25} optical sensor (Hunter Associates Laboratory, Reston, VA); beverage without hydrocolloids was considered to be the control sample. The device was calibrated using black and white tiles prior to measurement. The sample was placed in sample holding cup and covered with a cover cup. In colour values, *L** values indicate the level of lightness, ranging from 0 (black) to +100 (white); *a** value ranges from -100 (greenness) to +100 redness and *b** values ranges from -100 (blueness) to +100 (yellowness). The colour difference ΔE was calculated using L*, a* and b* values (Wibowo et al., 2015).

Zeta potential

In order to measure the zeta potential (Z) of the beverage samples, seeds were separated from samples and the solution was loaded in cuvettes; Z was then determined using a zetasizer (Zetasizer Ver. 7.11, Serial Number: MAL1054413, Malvern Instruments Ltd) (Genovese and Lozano, 2001).

Viscosity measurement

Brookfield prime digital Viscometer (Model DV-I) was used to measure the viscosity at room temperature. For viscosity measurement 2 spindles (S61 and S62) were used, depending on the viscosity of the beverage at spindle speed of 100 rpm (Mutlu et al., 1999).

Organoleptic evaluation

Organoleptic evaluation was conducted using 5 points hedonic scale rating. Samples (100 mL) were presented to 10 semi-trained panelists. All panelists were in the age group between 22 to 30 years, with equal proportion of male and female candidates. Water was kept on the table for panelists to clean the palate between samples. Colour, flavour, mouth feel, flow, even dispersion of basil seeds and overall acceptability of the basil seed infused fruit-flavored beverage with different hydrocolloids were evaluated using 5 points hedonic scale. Panelist gave their ranking from 1 to 5, representing unacceptable, relatively acceptable, good, very good, and excellent respectively (Abbasi and Mohammadi, 2013).

Statistical analysis

All the experiments were carried out in triplicate. Data was analyzed statistically to determine standard deviations and significance.

Results and discussion

Effect of hydrocolloids on CIE Colour (L, a*, b* and ΔE)*

Effect of different hydrocolloids concentration on CIE colour (*L**, *a**, *b**) values of basil seed incorporated fruit-flavoured beverage is summarized in Table 1. There was no significant difference in brightness (*L**) values when compared to control samples (C), except for beverages containing Ge. Other indices like redness to greenness (*a**) of all beverage samples were almost similar. Yellowness to blueness (*b**) of the all beverage samples were almost similar except for beverage containing hydrocolloid XG. The colour properties of hydrocolloids XG and Ge and possible interaction of hydrocolloids with sugar show significant colour difference in the developed beverage when compared to the control sample (de Almeida Lins et al., 2014; Sharma et al., 2006).

Table 1. Effect of hydrocolloids on colour indices of basil seed fruit-flavoured beverage

	CIE Colour values			Colour difference(ΔE)
Sample	*L**	*a**	*b**	
C	23.13±0.81	-4.65±0.32	12.33±0.11	-
GA	22.58±0.65	-5.58±0.34	14.72±0.47	2.50±0.60
CRG	22.42±1.19	-4.90±0.50	14.59±0.39	2.52±0.59
Ge	12.18±0.87	-4.10±0.19	13.16±0.58	11.01±0.63
XG	22.03±0.47	-4.26±0.29	26.61±0.51	14.45±0.45

Values are means ± standard deviation (n=3); C-control; GA- Gum Arabic; CRG- carrageenan; Ge- gelatin; XG- xanthan gum

Effect of hydrocolloids on Zeta potential

The magnitude of the charge existing on colloidal particles decides the stability of the solution (Morrison and Ross, 2002; Hajmohammadi et al., 2016). When particles have large Zeta potential (Z) value, generally above the ± 30 mV, particles repel each other and maintain the stability of the solution. When the Z value is between ± 30 mV, particles agglomerate due to less potential difference between particles and dissolution medium. The developed beverages with different hydrocolloids show Z value from -6.24 to -34.1 mV which shows the effect of hydrocolloids on the zeta potential of the beverage. As seen in Fig. 2, the absolute Z amount of the beverage, without hydrocolloid and with hydrocolloid GA, CRG, Ge and XG gives the values -12, -11.1, -16.9, -6.24 and -34.1 mV respectively. High Zeta value of XG maintains the dispersibility of basil seeds. Except for XG, all the other hydrocolloids at selected concentration showed less zeta value and became unstable. Similar stability results were obtained in other fruit juices with XG as hydrocolloid (Genovese and Lozano, 2001; Mirhosseini and Tan, 2010).

Effect of hydrocolloids on viscosity

A gel network is formed through entwining and cross-linking of the polymer chain present in hydrocolloids to form a three-dimensional network. This network formation depends on inter chain linking property of the hydrocolloids used (Djabourov, 1991; Burey et al., 2008). The high viscosity and ability to form gel-like structure of hydrocolloids help in the even dispersion of seeds. Based on the viscometer readings (Fig. 3), beverages with hydrocollids GA, CRG, Ge and XG showviscosity of 7.32 ± 0.15, 6.76 ± 0.51, 5.98 ± 0.22 and 232.36 ± 0.55 cP, respectively. Except XG all the other hydrocolloids shows similar vicosity as that of cotrol sample with out hydrocolloids, 5.88 ± 0.6 cP. XG absorbes water quickly and produce viscous and stable solution with pseudo plastic behavior (Niknezhad et al., 2016). Due to this property XG gives good mouth feel, fluidity and adhesion when added to beverages (Sanderson, 1981; Katzbauer, 1998).

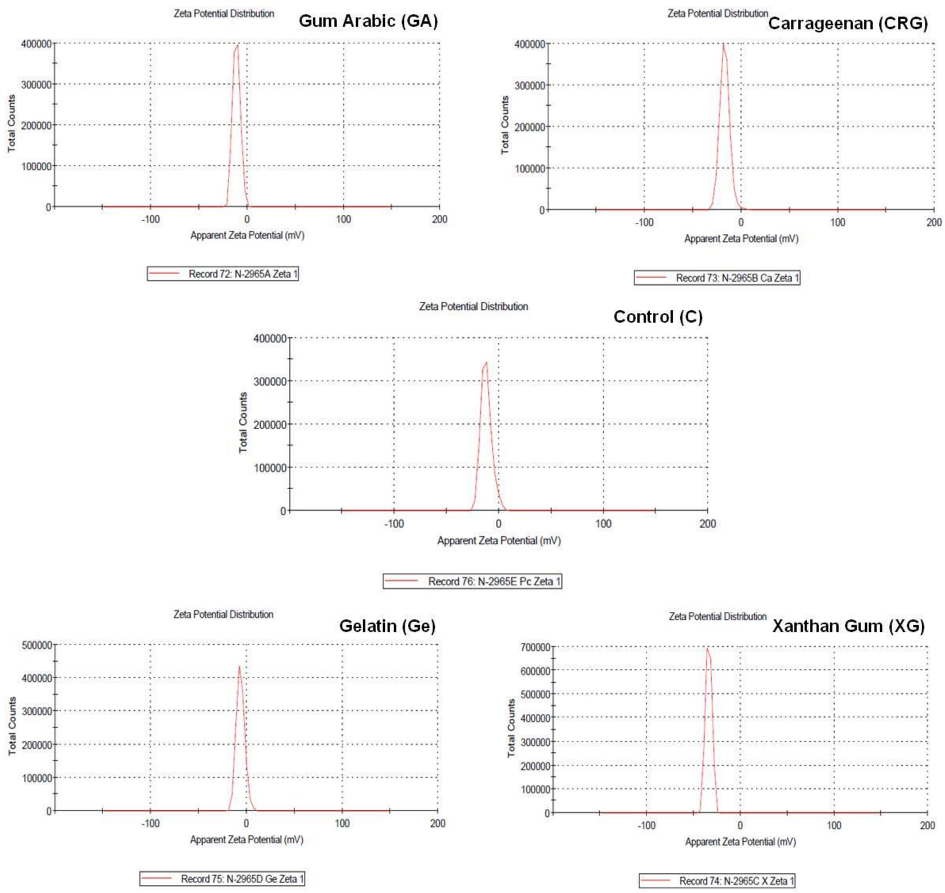

Fig. 2. Zeta analysis of basil seed fruit-flavoured beverage; C-control; GA-Gum Arabic; CRG-carrageenan; Ge-gelatin; XG-xanthan gum

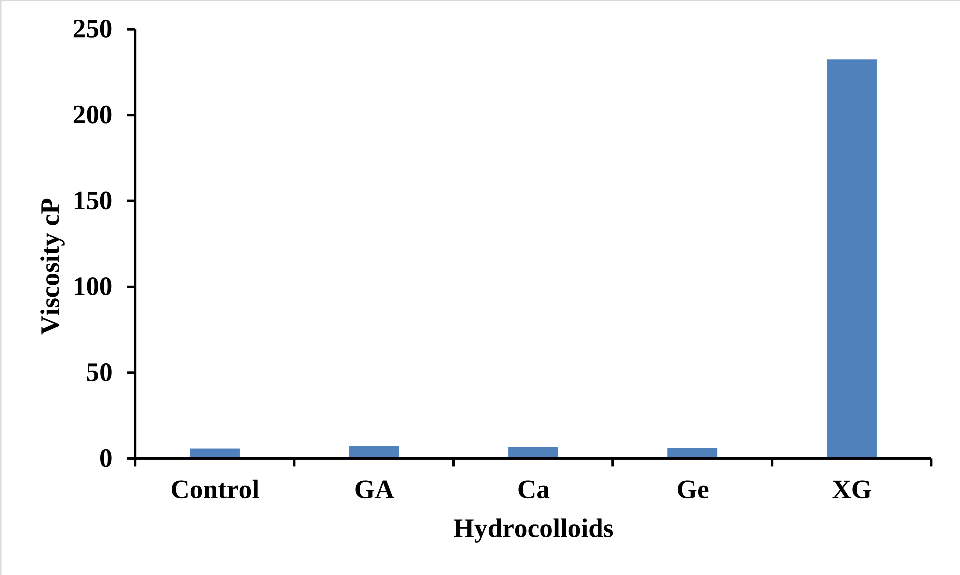

Fig. 3. Effect of hydrocolloids on the viscosity of basil seed fruit-flavoured beverage (C-control; GA- Gum Arabic; CRG-Carrageenan; Ge-Gelatin; XG-Xanthan gum)

Table 2. Organoleptic evaluation of basil seed fruit-flavoured beverage

Sample	Sensory property (Score out of 5)					
	Colour	Flavour	Mouth feel	Flow	Dispersion of seeds	Overall acceptability
C	4.8±0.42	3.9±0.31	4±0.94	4.2±0.42	1.1±0.31	3.2±0.81
GA	4.8±0.42	3.3±0.48	3.6±0.84	4.1±0.31	1.2±0.42	3.4±0.51
CRG	4.7±0.48	3.4±0.51	3.2±0.63	4.0±0.47	1.1±0.31	3.25±0.66
Ge	4.5±0.52	3.8±0.42	3.9±0.56	4.0±0.47	1.2±0.42	3.48±0.63
XG	4.2±0.42	3.8±0.63	3.2±0.78	3.2±0.82	4.8±0.42	3.84±0.78

Values are means±standard deviation (n=10). Score value indicates: 1-unacceptable; 2-relatively acceptable; 3-good; 4-very good; and 5-excellent. C-control; GA-Gum Arabic; CRG-carrageenan; Ge-gelatin; XG-xanthan gum

Effect of hydrocolloids on organoleptic qualities

The organoleptic evaluation of basil seed incorporated fruit-flavoured beverage are listed in Table 2. It can be observed that only XG hydrocolloid has higher mean scores, while all the other hydrocolloids have significantly lower value. Though significant colour difference was observed in hunter colour Lab (as listed in Table 1), the panelists were not able to distinguish any significant difference in colour among beverages. Higher viscosity of beverage with XG hydrocolloid, which reduced the mouth acceptability compared to the control sample, was observed by panelists. The viscosity increased by XG offered even dispersion of basil seeds in the fruit flavored beverage. No other hydrocolloids studied were able to maintain even dispersion of basil seeds. Based on overall acceptance parameters including even dispensability of seeds, beverage containing XG achieved the highest acceptance score.

Conclusion

Functional beverages are nutrient rich beverages with potent health benefits. Hydrocolloids are long chain hydrophilic polysaccharides and some proteins, with large number of hydroxyl groups. Hydroxyl groups on hydrocolloids increase affinity for binding water and help in producing dispersion. Dispersed hydrocolloids absorb water and swell which in turn increases the viscosity of liquid phase and produces colloidal suspension. The increased viscosity helps in dispersion of solid particles and maintains even dispersion. In this study, different hydrocolloids (gum arabic, carrageenan, gelatin, and xanthan gum) were used to evenly disperse the health-promoting dietary fiber rich basil seeds in fruit flavoured beverages. Though these hydrocolloids have gel forming and stabilizing properties, some failed to give even dispersion at fixed concentrations. This may be due to lower concentrations used to obtain better mouthfeel during preliminary studies. Among these, xanthan gum at concentration of 0.3% w/v was able to maintain even dispersibility of basil seeds through its increased viscosity and stabilizing action. The functional beverage developed in this study has good organoleptic property and consumer acceptance with health-promoting basil seeds suspended in it.

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