BIOSCIENCES BIOTECHNOLOGY RESEARCH ASIA, March 2023. Vol. **20**(1), p. 263-269

Nutritional and Sensory Characterization of Watermelon Rind Powder Incorporated Crackers

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http://dx.doi.org/10.13005/bbra/3087

(Received: 21 January 2023; accepted: 04 March 2023)

Watermelon, is a seasonal fruit with 91% of waterand is relished for its taste, good appeal and nutritional properties. The rind which occupiesa huge volume of the fruit is often disposed off and contributes to a large share from fruit waste. Watermelon rind is known to be a source of moisture, carbohydrate, protein, vitamins, minerals and phytochemicals. This study was framed with the intention of incorporating the wellness of watermelon rind in the commonly consumed snack, crackers. The watermelon rind was dried and powdered by using standard procedures. The powdered rind was incorporated in the ratio of 10%, 20% and 30% to the refined wheat flour and three variations of crackers namely C1, C2 and C3 were formulated. A significant difference (P<0.05) was found in the means of all the organoleptic parameters and the highly accepted variation in terms of organoleptic evaluation namely C3, was further subjected to nutritional evaluation.When compared with the control crackers the watermelon rind flour (30%) incorporated crackers was found to be superior in nutritional aspects.

Keywords: Citrulluslanatus L.; Crackers; Rind; Value addition; Watermelon.

Watermelon, (*Citrulluslanatus L.*) primarily contains 91% of water, 6% sugar and is a source of amino acid citrulline, Vitamin C, potassium, and antioxidant lycopene. The nature has bestowed us with this excellent thirst quencher, timely, during summer. There are different varieties of watermelon which differ in size, shape, colour of the rind, colour of flesh and so on. To mention a few, based on the colour of the rind viz. Sugar baby variety has bluish-black outer skin, improved shipper variety has dark green outer skin, Arkajyoti has light green rind with dark green stripes, ArkaManik variety shows green rind with light green stripes, Durgapurameetha light green coloured skin watermelon, and DurgapuraKesar variety is with green coloured rind with stripes[1]. Figure 1illustrates different varieties of watermelon with differences in rind and flesh.

The rind and seeds, major constituents(30%) of the fruit are often thought as waste and either used as animal feed or discarded. The edible watermelon rind approximates to about 40% of the total watermelon mass yet is often discarded as waste[2]. The direct disposal of the watermelon rind causes environmental issues, hence it would be ideal to take the advantage of the nutritional potential of watermelon rind and make products of commercial value, instead of limiting it

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to agricultural waste.The polysaccharide contentof the rind [3]has been a potential reason for its reuse[4], thereby tolessen the accrual of watermelon rind as waste by transforming the polysaccharides in the watermelon rindto new productslike biosorbent[5], bioremediation[6], biochar[7], and bioethanol[8].

With a revolution in the food industry and awareness created on health and environment, the fruit and vegetable wastes like pomaces, rinds and seeds are thought of nutrient treasures and are considered as a means of value addition to commonly consumed calorie rich bakery foods like cakes, cookies, breads[9]and in the formulation of pickles and jams[10]. Watermelon rind, considered as a potential source of dietary fiber, phenols, found to have high free radical scavenging property and antidiabetic activity in albino mice[11].A single dose of microencapsulated watermelon rind containing 4 g of L-citrulline seems adequate to improve endothelial function [12]. Watermelon rinds had moisture (10.61%), ash(13.09%), fat(2.44%), protein(11.17%) and carbohydrates(56.00%). The greater free radical scavenging activity and â-carotene were present in significant amounts. It contained different types of phenolic compounds, the most abundant one was 4-hydroxybenzoic acid (958.3 ìg/g dw) followed by vanillin (851.8 ìg/g dw), while the lowest phenolic compound was coumaric acid (8.8 ìg/g dw)[13]. More precisely, a 1" cube of watermelon rind provides 1.8 calories and a serving provides 2% of the recommended daily intake of vitamin C and 1 % of the vitamin B-6[14].

Crackers is a widespread snack with easy accessibility, affordability, long shelf life and suitable for all age groups. As, wheat flour or all-purpose flour is the major ingredient in cracker along with sugar and fat, carbohydrate becomes the major nutrient in crackers and the other desirable nutrients and non-nutrients like dietary fiber are found to be deficit. At present, studies focus on formulation oflow-carbohydrate food products by increasing the level of indigestible carbohydrates. Wheat flour or refined wheat flour, which is rapidly digested and absorbed in the duodenum and proximal regions of the small intestine, leads to a rapid increase in blood glucose levels, when high glycemic foods are consumed. A way to reduce the glycemic index in bakery products would be the partial substitution of wheat flour with flours, rich in indigestible carbohydrates. Literature search showed that the blends of acha and pigeon pea[15], corn silk[16], red onion skin[17], pea peel[18], defatted coconut flour[19], jelly fish[20], Hibiscus sabdariffa calyxes' residue[21], pumpkin seed flour[22], etc. had been used as prospective ingredients to formulate value added crackers.In this regard, watermelon rind, as a source of fibre and nutraceuticals, is used in this study as a means to reduce the rate of absorption of glucose from crackers.

METHODOLOGY

Preparationand Assessment of watermelon rind flour

The dark green coloured watermelon was purchased, the rind was gathered, washed, cut into pieces and shade dried. Moisture was found to be completely removed on the 7th day, where weight loss was used as an index to detect the extent of drying[15]. The dried rind was powdered in the mixer and seived.

The prepared composite flour mix with refined wheat flour and watermelon rind flour(Control- 100:0, C1- 90:10, C2- 80:20, C3- 70:30), were assessed for functional properties like moisture, water absorption index, oil absorption capacity, swelling capacity, hydration index, and bulk density.

Formulation of watermelon rind flour substituted crackers

The dough for crackers formulation was made by blending refined wheat flour, watermelon rind flour mixed in different proportions viz. (C1- 90:10, C2- 80:20, C3- 70:30), baking powder, a pinch of salt and shortening, while for the control crackers watermelon rind flour was not used. The prepared dough was rolled, cut, baked at 210^{o}C for 15 minutes[16]. The well baked control, C1,C2 and C3 variations of crackers were cooled and evaluated for organoleptic acceptability.

Organoleptic evaluation of the formulated crackers

A set of 20 panel members rated all the variations of crackers on a 9-point hedonic rating scale for organoleptic properties like colour, appearance, texture, flavor, taste and overall acceptability.

Nutritionalevaluation of the accepted variation of crackers

The accepted variations of crackers were evaluated for nutrients like energy, carbohydrate, protein, fat, zinc, iron, calcium, phosphorus and non-nutrients like fibre as per the standard procedures [17].

Statistical analysis

The descriptive statistical analyses were performed and the mean values were subjected to Analysis of variance with DMRT ($P<0.05$) to determine the significant difference in the developed variations of crackers[18].

RESULTS AND DISCUSSION

Assessment of watermelon rind flour

The functional properties of flour serve as an index to test their suitability in food product formulations. The above table values show that functional property values of composite flours were in par with the refined wheat flour and hence found suitable for preparing crackers. The composite mix watermelon rind flour and wheat flour (30:70) for bread formulation showed water absorption capacity of 3.044g/g, Oil absorption capacity of 2.150g/g, Swelling capacity of 6.894g/g and bulk density was 0.54g/ cm^3 [19], the difference in the value obtained in this study when compared with literature may be attributed to the fact that refined wheat flour has been used in this study for crackers formulation, while whole wheat flour had been used for bread formulation.

Organoleptic evaluation of the formulated crackers

The Duncan's Multiple Range Test in the above table shows that there is a significant difference in all the parameters of organoleptic evaluation namely color, appearance, texture, flavor, taste, and overall acceptability between control and the developed variations of crackers. Among the different formulations of crackers variation 3 (C3), 30% of watermelon rind flour substitution has the highest overall acceptability. A similar study has shown that cookies formulated with 30% watermelon rind flour incorporation had

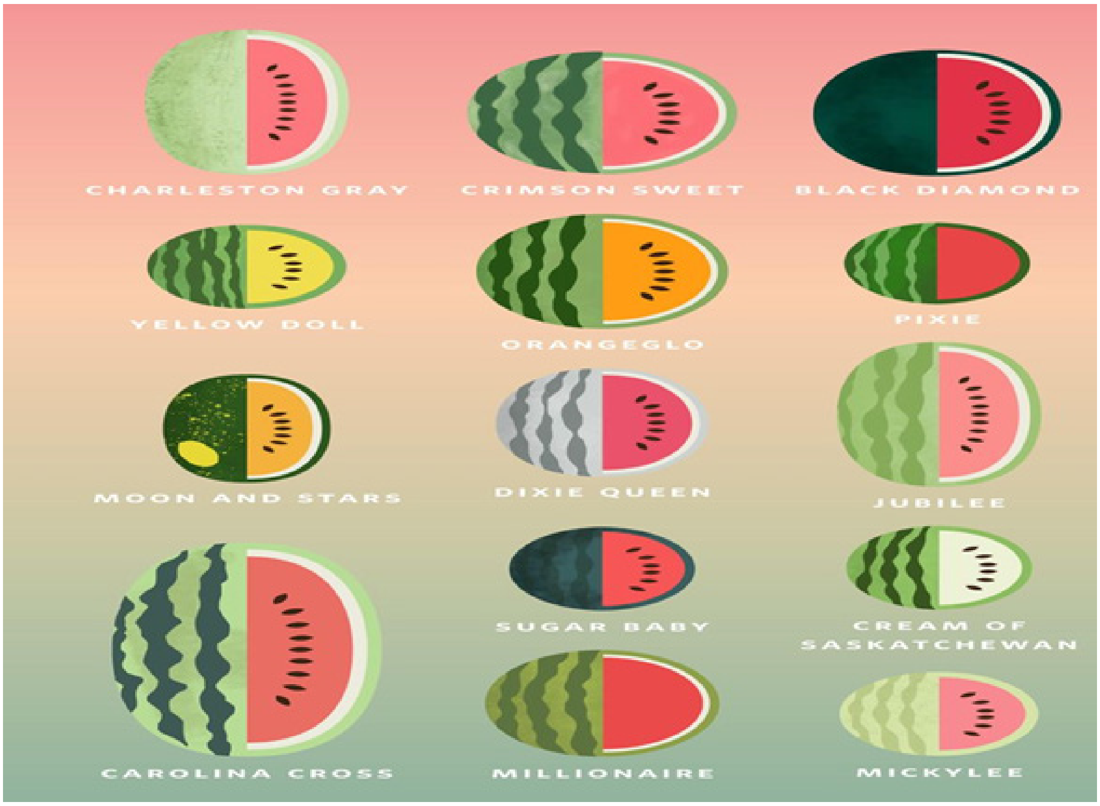

Fig. 1. Varieties of watermelon

the highest overall acceptability (8.23)[20]. The variation with the highest overall acceptability, C3 has been tested for nutrients and phytochemicals.

Nutritional evaluation of the accepted variation of crackers

Table 3 depicts that in comparison with the control crackers except for energy and carbohydrate all the other nutrients and fibre was found to be higher in watermelon rind flour incorporated cookies. The fibre from fruits and vegetables has proved to be beneficial for many metabolic disorders. A study in which the cookies formulated with 2.5% watermelon rind flour had shown a significant increase in mineral and vitamin contents[21]. It is also studied that up to 20% of watermelon rind powder in the cookie making increases dietary fiber, decreases predicted glycemic index to medium,and improves the antioxidant activity, withoutaffecting the acceptability of the cookie[22], in another study, the cooking yield and cooking loss were at maximum with the incorporation of 15% rind powder in

Table 1. Functional properties of control and variations of composite flour

Functional property	Control	C1 (10g watermelonrind powder)	C2 (20g watermelonrind powder)	C3 (30g watermelonrind powder)
Moisture (%)	5.2	6.1	6.2	6.2
Water absorption capacity (%)	142.6	142.4	141.3	141.2
Oil absorption capacity (%)	156.03	156.1	155.8	155.6
Swelling capacity (g/ml)	0.76	0.76	0.71	0.71
Hydration index (%)	1.54	1.49	1.49	1.48
Bulk density (g/ml)	0.62	0.66	0.63	0.62

Table 2. Statistical analysis of organoleptic evaluation of formulated crackers

Variations	Colour	Appearance	Texture	Flavour	Taste	Overall Acceptability
Control	8.6±0.24^a	8.8±0.29^a	8.8±0.61^a	8.8±0.73^a	8.7±0.26^a	8.8±0.51^a
C1	7.6±0.81^c	7.6±0.95^c	7.9±0.63^b	7.6±0.23^c	7.7±0.21^c	7.3±0.63^c
C2	7.8±0.11^b	7.7±0.15^c	7.9±0.58^b	7.6±0.29^c	7.9±0.32^b	7.6±0.24^c
C3	8.1±0.84^b	7.9 ±0.26^b	8.0±0.50^b	8.1±0.76^b	8.2±0.44^a	8.1±0.57^b

Values are mean ± SD. Samples with different superscripts across the column, where $^{a<b<c}$ using Duncan's Multiple Range Test are significantly different at ($P \leq 0.05$).

Table 3. Nutritional evaluation of the accepted variation of crackers

S. No	Nutrients /100 gms of Crackers	Control	30% Watermelon rind flour incorporated crackers (C3)
1	Energy(kcals)	182	174
2	Carbohydrates(g)	23	21.2
3	Protein(g)	4	11.64
4	Fat(g)	18	13.5
5	Dietary fibre(g)	1.02	12.75
6	Zinc(mg)	0.3	3.2
7	Iron(mg)	1.78	5.63
8	Calcium(mg)	29	53.52
9	Phosphorus(mg)	17	69.21

noodles, and it was also found that the sensory evaluation indicated that the noodles with 10% watermelon rind powder, was most accepted among the value-added noodles[23]. It was also studied that, the wheat flour can be substituted with watermelon rind and orange pomace flours up to 10% without adversely affecting the overall quality attributes of the biscuits[24],while in this study it has been possible with up to 30% of incorporation of watermelon rind flour. Literature also states that watermelon rind contained more citrulline, a non-essential aminoacida potential antioxidant and a vasodilator, than the flesh[25]and contains major volatile compounds of nine-carbon aldehydes and alcohols representing aroma[26].

CONCLUSIONS

Agro-wastes are the large volumes of solids waste resulting from the production, preparation and consumption of fruit and vegetable pose potential disposal and pollution problems along with loss of valuable biomass and nutrients. There is a potential for conversion of agro-wastes into useful products or even as raw material for other industries. The utilization of wastes of fruit and vegetable processing as a source of functional ingredients is a promising field[27]. Thus, this study concludes that the watermelon rind a major waste from watermelon fruit has huge nutritional potential and can be effectively used in food formulations. A significant increase in the watermelon rind flour incorporated crackers protein, fibre, iron, zinc calcium and phosphorus was found along with a significant reduction in energy, carbohydrate and fat is worth mentioning. Therefore, watermelon rind flour can be used as a source of fibre and nutrients and further studies may include the phytochemical screening and antioxidant studies from watermelon rind flour incorporated food formulations.

ACKNOWLEDGEMENT

None.

Conflict of Interest

There is no conflict of interest.

Funding source

There are no funding sources.

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