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Antioxidant, dietary fiber, micronutrient rich carrot pomace cake for mitigating hidden hunger

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Abstract
The present study was undertaken with the objective to develop nutrients rich cake supplemented with carrot pomace in different ratios for mitigating the hidden hunger. Carrot pomace was mixed with refined flour for preparation of cake. The cake were analyzed for dietary fibre, total minerals, total phenolic content, total flavonoids content and total carotenoids content. These recipes were also evaluated organoleptically using nine point scale. Incorporation of carrot pomace in baked recipes preparations are recommended to enhance the minerals, dietary fibre and total carotenoids contents of diets for combating hidden hunger.

Keywords: Carrot pomace, hidden hunger, organoleptic, incorporation

1. Introduction
Elements, which are needed in minute amounts, and vitamins, which have significant effects on both human and animal health, are examples of micronutrients (Maggini *et al*., 2018) [11]. The micronutrients are the most vital in the universe for both animals and people to survive therefore; the hazard to human health worldwide is greater when the micronutrients are deficient in diet. All age groups are susceptible to micronutrient and vitamin insufficiency, although youngsters (under five years) and expectant mothers are the most at risk (Miller & Welch, 2013) [13]. One in three people worldwide suffer from micronutrient insufficiency, sometimes known as hidden hunger since its symptoms include more subtle indicators of malnutrition as a result of inadequate consumption of the necessary micronutrients (Bhandari & Banjara, 2015) [5]. Even if a person has access to enough calories, they could not have enough micronutrients (Kennedy *et al*., 2007) [8]. Because its symptoms are not always visible and people may not even be aware of it, this condition has been termed "hidden hunger." It has disastrous, perhaps permanent effects on mental incapacity, productivity, and health (Micronutrient Initiative. 2010) [12].
A healthy diet is one that meets all of the fundamental dietary requirements for humans as well as their demand for energy (Nishida *et al*., 2004) [14]. Our country's food system is failing to provide sufficient amounts of wholesome, nutritionally balanced food, especially to the underprivileged and resource-poor, which is causing micronutrient malnutrition. Security of food and nourishment is thus one of humanity's greatest issues. A considerable portion of the population relies on a diet based on cereal and has limited access to meat, fruits, and vegetables, mineral (Fe, Zn) and vitamin A malnutrition is a serious food-related public health concern affecting children and women (Fiedler, 2000) [6].
Daucus carrot L., also known as the carrot, is economical and incredibly nutritious vegetable since it is high in several essential bioactive molecules such as carotenoids, fiber, phenolic compounds and also includes significant amounts of minerals (Baljeet *et al*., 2014) [4]. Carrot pomace is considered as the major byproduct remaining after industrial juice extraction; up to 50% of the raw material used to make carrot juice is left behind as pomace, which is mostly used as animal feed (Hernández-Ortega *et al*., 2013) [7].
However, this pomace is rich in beneficial substances including antioxidants, dietary fiber and carotenoids. This might be utilized successfully to create fiber-rich value-added baked products without compromising flavor or convenience, not only offering a healthy product but also assisting in the effective usage of carrot pomace (Aglawe and Bobade 2018) [2].

2. Material and Methods

2.1 Procurement of raw materials

The study was carried out in Department of Foods and Nutrition, CCSHAU, Hisar from year 2020 to 2022. Carrots (Hisar Garric Variety) were procured from Vegetable Department, College of Agriculture, CCSHAU, Hisar. All other ingredients were procured from local market of Hisar.

2.2 Preparation of carrot pomace

The carrots were washed in running tap water number of times to remove extraneous material. Trashes were removed with a plane stainless steel knife followed by trimming. A juicer mixer grinder cum food processor was used to extract carrot juice. After the juice extraction, pomace was collected. The pomace so obtained was stored in sealed polythene bag for further use.

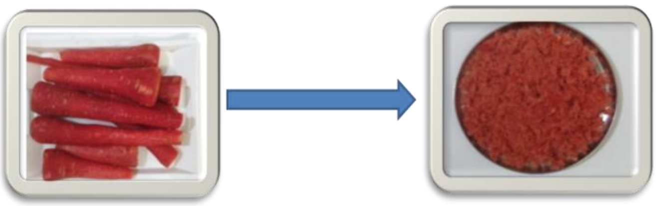

Fig 1: Carrot pomace extraction

2.3 Formulating fresh carrot pomace cake

The ingredients used for preparation of cake were refined wheat flour (62.5 g), carrot pomace (62.5 g), milk made (130 ml), refined oil (100 ml), baking soda (1/2 tsp) and baking powder (1/2 tsp). Cake were prepared from different blends refined wheat flour and carrot pomace in respective ratios of Control (100% refined wheat flour), Type-I (75:25), Type-II (50:50), Type-III (25:75). Refined wheat flour cake (100% refined wheat flour) was taken as control. Cake batter was prepared manually and poured into greased tin and baked at 160 ^{0} for 35 minutes. After baking, covered the cake tin with cloth for 30 minutes to cool removed gently cake from the cake tin and served.

Fig 2: Organoleptic characteristics of cake

2.4 Organoleptic evaluation

Among different types of cake, Type-II (50% refined wheat flour + 50% carrot pomace) cake scored maximum mean score for all sensory attributes i.e. 8.10 ('liked very much'). Type-II cake was selected for nutritional evaluation on the basis of organoleptic score (Figure 3).

2.5 The following parameters were examined chemically in the devised cake

2.5.1 Dietary fiber and total mineral content

The enzymatic approach described by (Khare *et al.* 2021) [9] was used to determine the total, soluble, and insoluble dietary fiber components. Following the procedures outlined by (Lindsey and Norwell 1969) [10], total mineral content was calculated. In a 150 ml conical flask, a two g sample was collected. This was mixed with 20 ml of a diacid mixture (HNO3: HClO4: 5:1, v/v) and stored overnight. The next day, the white precipitates were digested, and distilled water was added before being filtered through Whatman No. 42. In order to evaluate calcium, iron, zinc, and phosphorus, the filtrate was diluted to 100 ml with double-distilled water.

2.5.2 Total phenolic content, total flavonoids and total carotenoids content

The concentration of total phenolics of the methanolic extracts was determined by the Folin-Ciocalteau colorimetric method (Singleton and Rossi., 1965) [15]. The phenolics present in plant extract reacted with specific redox reagent (Folin-Cioclteau reagnent) to form blue chlorophore constituted by a phosphotungstic phosphomolybdenum complex which was measured at 750 nm.

The amount of flavonoids content in methanolic extracts was determined by aluminium chloride colorimetric method (Zhishen *et al.*, 1999) [17]. The natural flavonoids compounds present in the sample extracts reacts with sodium nitric; the pink colored flavonoids-aluminium complex developed using aluminium chloride in alkaline condition which was measured at 510 nm.

The total carotenoids are extracted and partitioned in organic solvent (acetone and methanol) on the basis of their solubility. Carotenoids that are bound as esters are hydrolyzed using aqueous 60% KOH. The amount of carotenoids present in sample is estimated calorimetrically at 450 nm using β-carotene standard (Wellburn, 1994) [16].

2.5.3 Statistical analysis

The data were subjected to statistical analysis using the Statistical Package for Social Science (SPSS) version 2.0. The values were collected in triplicate. At a 5% and 1% level of significance, the difference was examined for significance.

3. Result and Discussion

3.1 Dietary Fibre

The total fibre content of control cake was 8.05 g/100g and that of Type –II cake was 39.81 g/100g, respectively (Table 1). The soluble dietary fibre content of control cake was 2.59 g/100 and in carrot pomace cake it was 9.89 g/100g, respectively and insoluble dietary fibre content of control cake was 5.46 g/100 g and in cake supplemented with 50% carrot pomace it was 29.93 g/100 g, respectively. Significant increase was observed in total, soluble and insoluble dietary fiber content of Type-II cake.

Table 1: Dietary fibre contents of fresh carrot pomace based baked product (g/100g, on dry matter basis)

Products	Total dietary fibber	Soluble dietary fiber	Insoluble dietary fiber
Control(100% RF)	8.05±0.17	2.59±0.34	5.46±0.18
Type-II (RF:FCP::50:50)	39.81±0.15	9.89±0.21	29.93±0.07
't' value	242.45**	74.27**	220.73**

Values are mean ± SE of three independent determination
RF- Refined wheat flour, FCP- Fresh carrot pomace
** Significant at 1% level of significance

3.2 Total minerals

The calcium content in refined wheat flour cake 46.31mg while Type-II cake contained significantly higher amount of calcium 67.32 mg/100g (Table 2). The iron content in carrot pomace cake was 3.54 mg per 100 g which was significantly higher than the control cake *i.e.* 3.17 mg/100 g. The zinc content of control cake (100% refined wheat flour) was observed 2.75 mg per 100 g which was significantly increased in Type-II cake *i.e.* 2.95 mg/100 g. The phosphorus content of value added cake (Type-II) was 168.05 mg/100 g was also significantly higher than the control (157.79 mg per 100g).

Table 2: Total minerals content of fresh carrot pomace based baked products (mg/100g, on dry matter basis)

	Total minerals content			
Products	Calcium	Iron	Zinc	Phosphorus
Control(100% RF)	46.31±0.79	3.17±0.02	2.75±0.05	157.79±2.85
Type-II(RF:FCP: 50:50)	67.32±0.75	3.54±0.03	2.95±0.04	168.05±1.81
't' value	33.43**	18.86**	5.23**	5.94**

3.3 Total phenolic content, total flavonoids and total carotenoids content

Total phenolic content of control cake was 48.23 GAE/100 g and in 50% value added carrot pomace cake, it was 743.56 GAE/100g. Significant increase was observed in total phenolic content of Type-II cake compared to control. Total flavonoid content of Type-II cake was 0.26 mg QE/100g was observed while in control it was found zero. Total carotenoids content of refined wheat flour cake (Type-II) was 224.67 µg /100g in that of Type-II cake it was observed 2996.81 µg /100g, which was significantly higher ($p \leq 0.05$) than control cake.

Table 3: Total phenolic content, total flavonoids and total carotenoids content of value added carrot pomace baked product

Products	Total Phenolic content (GAE/100g)	Total Flavonoids (mg QE/100g)	Total carotenoids (µg /100g)
Control (100% RF)	48.23±1.83	Nil	224.67±5.43
Type-II (RF:FCP: 50:50)	743.56±1.70	0.26±0.05	2996.81±5.33
't'-value	8.03**	8.83**	3.78**

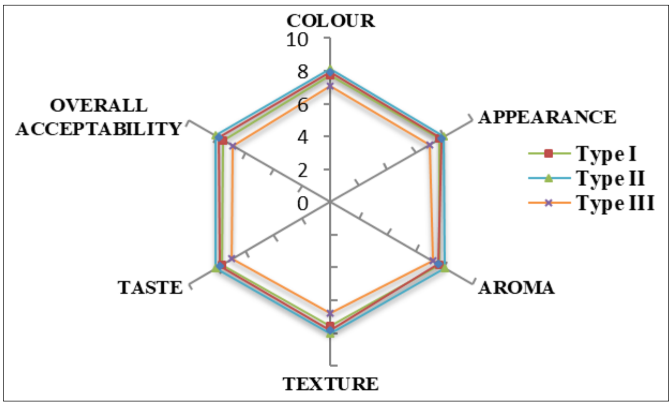

Fig 3: Sensory evaluation of cake

4. Conclusion

Fresh carrot pomace was effectively incorporated in refined flour cake. Substitution of 50% fresh carrot pomace resulted in the cake with best sensory acceptability and high nutritional composition. Dietary fiber, minerals, total phenolic content, total flavonoids content, and total carotenoids content all are increased significantly after substitution of fresh carrot pomace with refined flour.

5. Acknowledgment

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