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IMPROVEMENT OF DIETARY FIBER CONTENT AND ANTIOXIDANT PROPERTIES IN CHAPATTI WITH THE INCORPORATION OF DPPP

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ABSTRACT:

Pomegranate (Punica granatum) peel is rich source of dietary fiber and bioactive compounds, hence, attempt was made to see the effect of dried dried pomegranate peel powder (DPPP) on the bioactive constituents and micro structural quality of chapatti. Chapatti dough prepared from 5, 7.5 and 10% DPPP was examined for dough stickiness, dough strength and dough hardness. With increased level of DPPP, dough stickiness increased due to increased water absorption capacity whereas dough strength and dough hardness decreased due to presscence of large amounts of dietary fibre in DPPP. Chapatti incorporated with 10% DPPP showed DPPH radical scavenging activity up to 64.4% showing presence of active antioxidants. The microstructure of chapatti prepared from dough added with 10 % starch granules, fibrous structures and protein bodies were adhered to starch granules and protein matrix while in the control protein is seen either in association with starch granules or as clusters of storage protein. Chapatti's prepared from DPPP had softer chapatti.

KEYWORDS: Dried pomegranate peel powder (DPPP), Chapatti, Microstructure, antioxidant activity, Dough texture, SEM.

I. INTRODUCTION

Pomegranate (Punica granatum L.) is a small tree that is native to the Mediterranean region and has been used extensively in the folk medicine of many countries (Negi and Jayaprakasha 2003). There is a growing interest in this fruit because it is considered to be a functional product of great potential benefit in the human diet as it contains several groups of substances that are useful in disease risk reduction and is of significant economic importance because the fruits are either consumed fresh or used commercially in the juice industries. Once the pomegranate juice has been extracted, the wastes that remain are composed mainly of two fractions: (1) pulp and bagasses; and (2) peel. Uses for these coproducts are scarce and their disposal represents a problem. However, because of their composition they have the potential to be used for other ends, for example, to obtain bioactive compounds and dietary fiber that could be used as ingredient in food processing (Viuda-Martos et al. 2011).Thus, new aspects concerning the use of these coproducts for further exploitation as food additives or supplements with high nutritional value have gained increasing interest because these are high-value products and their recovery may be economically attractive (Murthy and Naidu 2010).

Pomegranate peel comprise about 50% of the total fruit weight and is an important source of minerals especially potassium, calcium, phosphorus, magnesium and sodium; complex polysaccharides (Mirdehghan and Rahemi 2007) and high levels of a diverse range of bioactive compounds such as phenolic acids, flavonoids, proanthocyanidin compounds(Li et al. 2006) and ellagitannins, such as punicalagin and its isomers, as well as lesser amounts of punicalin, gallagic acid, ellagic acid and ellagic acid-glycosides (hexoside,pentoside, rhamnoside, etc.) (Devatkal et al. 2010).

Wheat is one of the daily staple foods in India and 90 % of the wheat produced is consumed mainly in the form of chapatti. Softness and flexibility are the most important quality parameters for chapatti. Chapatti is very susceptible to moisture loss and staling after baking. Chapatti is abundant source of dietary fibre that helps in diverticular diseases and reduces constipation and rate of chronic bowl diseases and diet related cancers. Since, chapatti is consumed every meal of the day, with the addition of dried pomegranate peel powder (DPPP), it could be a good vehicle with improved nutritive value. With this background, an attempt was made to study the effect of incorporation of dried pomegranate peel powder (DPPP) on the bioactive constituents and micro structural quality of chapatti. With this background, the aim of the present work is to provide chapattis with enhanced nutritive value, prolonged shelf life and better micro structural quality.

II. MATERIAL AND METHODS:

A. WHOLE WHEAT FLOUR:

It is milled from the whole grain—the bran, the germ, and the endosperm. Mostly it is milled from the semi-hard wheat varieties, also known as durum wheat. Hard wheat have a high gluten content, which provides elasticity, so doughs made out of atta flour are strong and can be rolled out very thin. It is full-flavored flour containing vitamins, minerals protein and fibres. Whole-grain whole wheat flour is more nutritious than refined white flour whole wheat flour

B. DRIED POMEGRANATE PEEL POWDER:

Pomegranate fruits were procured from local fruit market. The peels were removed, washed with water, cut into small pieces (approx. 1_1 cm) and shade dried at room temperature of about 35°C. The dried peel were coarsely powdered in a blender, passed through 250-mm sieve, coded as dried pomegranate peel powder (DPPP) and stored in 250 gauge polythene bags.

C. PREPARATION OF BLENDS

Based on preliminary baking trials, blends were prepared using mixture of wheat flour and DPPP in the ratio of 100/0, 97.5/2.5, 95/5, 92.5/7.5 and 90/10 and packed in polypropylene bags.

D. PREPARATION OF DOUGH

The whole wheat flour (100g) was mixed with required amount of water judging the suitability with kneading so that dough is neither too sticky nor too dry. 2g of salt and varying concentrations (5, 7.5 and 10%) of dried pomegranate peel powder were added, all on flour basis. The control dough was prepared without adding the dried pomegranate peel powder. The dough was kneaded by hand for 10 min and covered with wet muslin cloth to rest for 15 minutes.

E. PREPARATION OF CHAPATTI

30 g of dough was taken and rolled into chapatti. The dough was then baked and the hot chapatti was cooled at room temperature and stored in polypropylene pouches

G. WATER ABSORPTION CAPACITY:

Water Absorption Capacities of the flour samples were determined (L.R. Beuchat, 1977).

One gram (1 g) of the flour was mixed with 10 ml of distilled water or oil in a centrifuge tube and allowed to stand at room temperature for 30 minutes. After standing at room temperature for 30 minutes, the sample was centrifuged for 25 minutes at 3000rpm. The sediments were weighed after complete removal of the supernatant at 40°C and WAC was calculated as:

$$WAC = \frac{W_2 - W_1}{W_o} \times 100$$

Where:
W_o = Weight of the sample
W_1 = Weight of centrifuge tube plus sample
W_2 = Weight of centrifuge tube plus the sediments

H. RHEOLOGICAL CHARACTERISTICS:

- **DOUGH COLOUR:** The colour of the control dough and the dough containing 5, 7.5 and 10, dried pomegranate peel powder was measured using Lovibond AT Series Reflectance Tintometer in terms of L* (lightness, ranging from 0 to 100 indicating black to white), a* (+a, redness and –a, greenness) and b* (+b, yellowness and –b, blueness).
- **DOUGH STICKINESS:** The textural characteristics, stickiness and hardness was evaluated by TA-XT Plus texture analyser (Stable Micro Systems, USA). At the centre of the dough penetrometry tests were performed. The cylindrical probe (P/5 model) with flat base of 5mm diameter was used as a plunger. The force required to penetrate the probe to the centre of the dough was evaluated.

I. ESTIMATION OF RADICAL SCAVENGING ACTIVITY:

The effect of extracts on DPPH free radical was estimated according to the procedure described byYi, Yu, Lianga, and Zeng (2008). Extract was prepared by taking 10 gram of freeze dried chapatti powder samples, were homogenized with 50 ml of ethanol in orbital shaker for 4 hours and then centrifuged 5000rpm for 30 minutes. The supernatant obtained was used for the determination of antioxidant activity.1 ml of the sample extract was added to 5 ml of 0.04g/l DPPH solution. It was kept in dark for 30 min, the absorbance was measured at 517 nm against a blank of ethanol.

The percentage of the DPPH radical scavenging was calculated by the following equation:

$$\%RSA = \frac{C - S}{C}$$

C- Net absorbance of control (DPPH sol)
S-Net absorbance of sample

J. SCANNING ELECTRON MICROSCOPY:

The freeze dried chapatti samples were powdered and used to study the microstructure by scanning electron microscopy(SEM). A Carl Zeiss Scanning Electron Microscope- EVO 18 Model was used. Samples were mounted on sample holders with the help of double-sided scotch tape and sputter coated with silver (2 min, 200 Pa). The preparations were

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transferred to the microscope where it was observed at 15 kV and a vacuum of 12.99 x10^{-3} Pa. Scanning electron micrographs with appropriate magnifications were selected for presentation of results. Using the images obtained by electron microscopy, the area and the granules of starch were determined. The effect of incorporation of DPPP on swelling properties as well as protein starch binding was observed.

K. SENSORY EVALUATION:

Chapattis were evaluated by a panel of judges. The parameters studied were taste, colour, flavour, texture and overall acceptability. The score card for the evaluation of the biscuits was provided along with instructions to each judge. The recipes were evaluated for sensory characteristics by the panel of judges.

III RESULT AND DISCUSSION:

A. CHEMICAL ANALYSIS:

The proximate composition of pomegranate peel powder is described below.

PARAMETERS	DPPP
Moisture (g%)	6.02±
Total ash (g%)	4.23±
Protein (g%)	3.38±
Fat (g %)	0.41±
Dietary fibre (g%)	27.6±
Iron (mg%)	21.03±
RSA (%)	81.6±

The pomegranate peel powder contains tremendous quantities of dietary fibre (27.6%). Since chapatti prepared by incorporation of DPPP has increase in the total dietary fiber content, it may be an alternative food for people with special calorific requirements and can be included in the category of functional foods.

B. PHYSICAL ANALYSIS

Table 1: Effect of DPPP On Water Absorption Capacity of Dough

SAMPLE	%WHC
Control	123.4
5%	141
7.5%	159
10%	166.5

The water absorption capacity (WAC) indicated the ability of flour to absorb with water under limited water condition. Major chemical compositions that influence WAC in flour were carbohydrates and protein due to the presence of hydrophilic part. WAC of PSM flour was high compared to control. Water absorption is potent for product characteristic that need starch retrogation, moistness and the subsequent product staling. Thus, the high content of WAC in PSM flour was probably because the present of soluble fiber in flour. Soluble fiber has high hydration ability and can form vicious solution. The high level of WAC in PSM flour could be useful for functional agent and thickening for food system such as baked products.

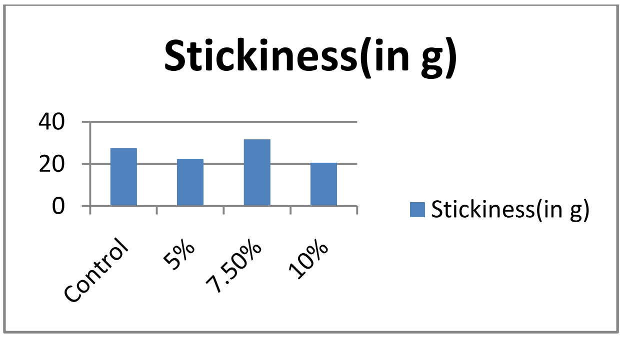
Table.2: DOUGH COLOUR

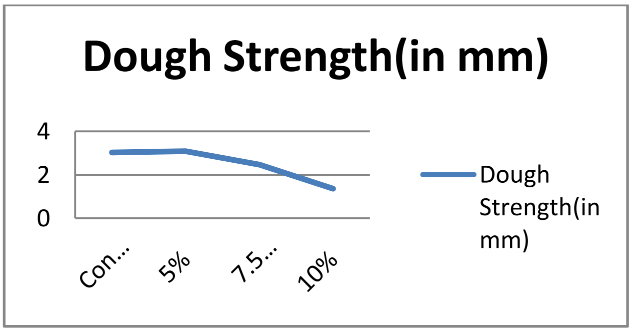
Dough Sample	l*	a*	b*
Control	62.51±1.03	6.40±1.47	23.97±0.96
5%	62.30±0.46	4.72±0.49	33.79±1.28
7.5%	61.60±2.1	4.59±0.97	33.67±0.71
10%	59.58±0.74	5.17±0.37	33.77±0.33

l* value is a measure of the light-dark (brightness) fraction of biscuit surface color. As shown in table, the 'L' value decreased with the increase in the levels of DPPP. Control dough had the highest brightness compared to the DPPP enriched dough. The change in a* value indicating redness decreased with the addition of DPPP. The change in 'b' value, which indicates the yellowness, increased with increase in DPPP level. The peel has polyphenol oxidase and peroxidase activities and they are rich in polyphenols, which are substrates for these enzymes. Therefore, due to the enzymatic browning, brightness of the dough may be decreased. Also, as DPPP has brownish color, its incorporation with wheat flour also decreased the brightness of the dough.

Table 3: DOUGH STICKINESS

SAMPLE	STICKINESS (in gm)	DOUGH STRENGTH (in mm)
Control	27.60±1.737	3.022±1.938
5%	22.395±5.221	3.083±1.767
7.5%	31.675±5.454	2.469±0.298
10%	20.635±3.436	1.363±0.694



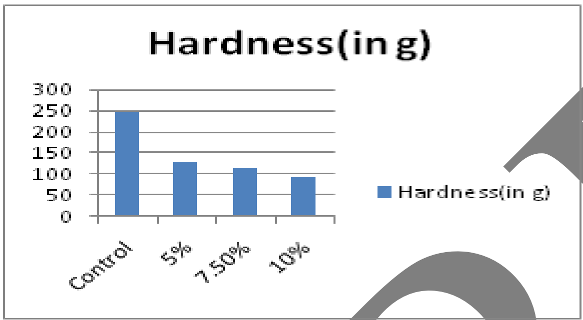


As observed the dough stickiness was increased due to increase in the water holding capacity of flour with addition of DPPP. But, due to the simultaneous action of high quantities of dietary fibre present, the dough lost its strength which can be observed from the above graph. The dough surface when in better contact with the surface of a probe, results in higher surface adhesion and hence the increased stickiness. But due to loss in strength it resulted in low values of stickiness although the dough was sticky.

Hence, it can be concluded that controlled amount of DPPP incorporation, upto 5% will be helpful to increase the stickiness as well as maintaining the dough strength. Further increase in concentration of DPPP would cause the dough to lose its strength and crumble easily.

Table 4: DOUGH HARDNESS

SAMPLE	HARDNESS
Control	245.548±1.860
5%	129.554±9.856
7.5%	115.105±9.392
10%	91.729±1.771



The conrol dough has maximum hardness. The hardness of dough shows a declining trend due to increase in fibre content and water holding capacity making dough more softer with increase in concentration of DPPP.

C. ESTIMATION OF RADICAL SCAVENGING ACTIVITY:

SAMPLE	%RSA
5%	29.61
7.5%	45.7
10%	64.4

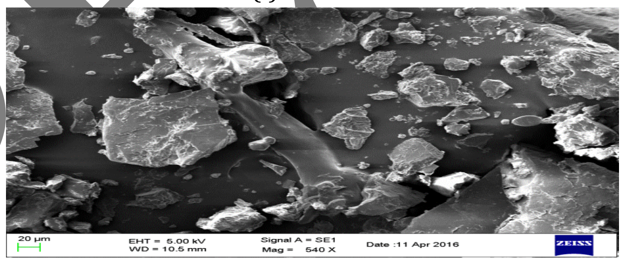
DPPP displayed very high radical scavenging activity of 81.6% indicating active nature of antioxidants comprising of phenolic acids, flavonoids, proanthocyanidin compounds and ellagitannins, such as punicalagin and its isomers, as well as lesser amounts of punicalin, gallagic acid, ellagic acid and ellagic acid-glycosides (hexoside, pentoside, rhamnoside, etc. polyphenols and flavanoids. The antioxidant activity of phenolic compounds is mainly attributed to their redox properties, which allow them to act as reducing agents, hydrogen donors and quenchers of singlet oxygen. In addition, they may also possess metal-chelation properties. As regards the tannins, it is known that these compounds can inhibit lipid peroxidation and lipoxygenase in vitro as well as it also demonstrated its ability to sequester radicals such as hydroxyl, superoxide and peroxyl.

It can be observed that as the concentration of DPPP in the chapatti sample increases the radical scavenging activity also increases proportionately. The radical scavenging activity was found to be highest in chapatti containing highest amounts of DPPP incorporation (10%).

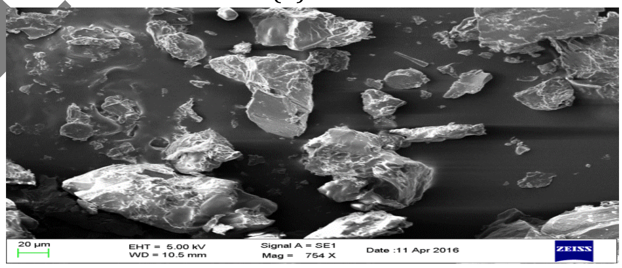
Although there is a significant increase in the contents of antioxidants incorporated with DPPP compared to control, the values are less than the theoretically expected values. This decrease may be due the thermal treatment which significantly decreases the polyphenol content. Exposure to heat as well as sunlight in presence of O2 results in oxidative degradation of carotenoids

D. SCANNING ELECTRON MICROSCOPY:

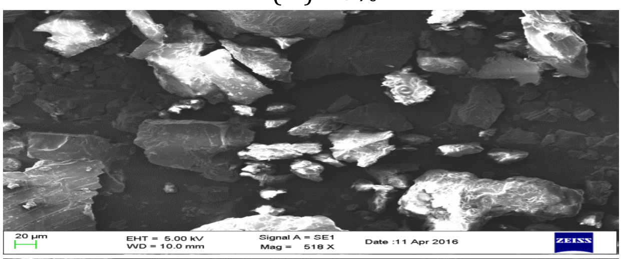
(i) Control

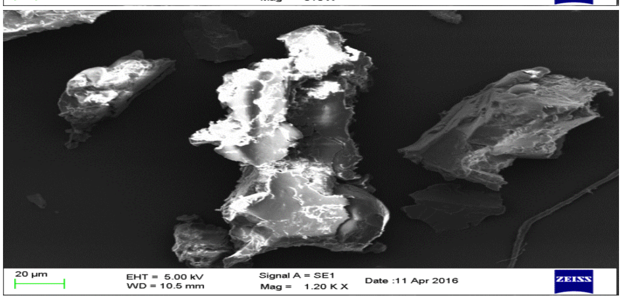


(ii) 5%



(iii) 7.5%





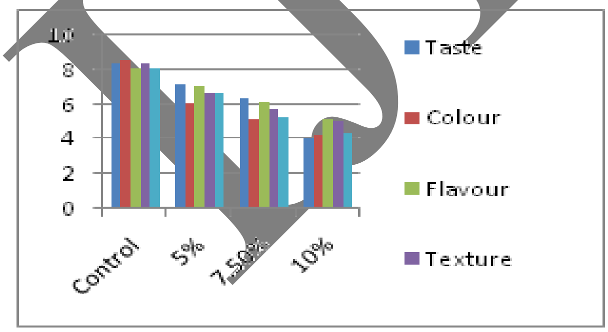
(iv) 10%

Scanning electron microscopy (SEM) was used to study the morphological characteristics of chapatti. The processing of PPP is known to give physical change, affecting morphological characteristics of PP. Chapatti was prepared using compound flour made by incorporation of DPPP to whole wheat flour. When heated (roasted) increased in particle size was observed due to gelatinization after breaking of molecules. Higher water retention, gelatinization changes are dependent on availability of heat and water. In the present work, the chapatti sample shows change in starch granules configuration and surface morphology after roasting. Compared to control, DPPP incorporated chapatti lose the surface smoothness and presented numerous wrinkles. In Figure (a), gelatinized starch granules is seen which are trapped in protein matrix. Thus, protein is seen either in association with starch granules or as clusters of storage protein. whereas in Figure (b) and (c), protein matrix, starch granules and fibrous structures is seen in combination. In Figure (d), starch granules, fibrous structures and protein bodies adhering to starch granules and protein matrix can be clearly seen.

F. SENSORY EVALUATION:

Sensory score of the Chapatti prepared from flour mix is as follows:

Parameter	Trials			
	Sample 1	Sample 2	Sample 3	Sample 4
Taste	8.4±0.978	7.2±0.86	6.4±0.87	4±0.91
Colour	8.6±0.856	6.1±0.89	5.2±0.897	4.2±0.927
Flavour	8.1±0.925	7.1±0.910	6.2±0.786	5.2±0.946
Appearance	8.6±0.784	6.25±0.976	5.2±0.893	4.9±0.971
Texture	8.4±0.88	6.75±0.968	5.8±0.934	5.1±0.961
Mouth feel	8.1±0.857	7.1±0.971	5.5±0.947	4.4±0.983
After taste	8.1±0.863	6.7±0.898	4.6±0.967	4.1±0.978
Overall acceptability	8.1±0.91	6.7±0.917	5.3±0.923	4.3±0.979



Sensory scores of Chapatti Samples containing different levels of DPPPare presented in Table.. The addition of DPPP was found to be acceptable up to 5% level of addition. However, as the level of DPPP was increased sensory scores decreased significantly as compared to the control. Lower scores were due to the following reasons:

- Bitterness: As the DPPP was untreated, with with increase in the concentrations of DPPP, the bitterness increased.
- Colour: The chapatti prepared with dough incorporated with DPPP showed significant drop in brightness as they turned pale compared to the control chapatti.
- Although a good indication is that there is not much drop in the flavor of the DPPP incorporated chapattis compared to control.
- It can be concluded that the chapattis with 5% DPPP incorporation could be used for consumption as with further increase in DPPP, bitterness increases. The problem of bitterness and colour could be resolved if we incorporate DPPP in traditional food items such as Masala Paratha and Thepla.

IV CONCLUSION:

The Pomegranate Peel Powder (PPP) was selected for incorporation due to presence of tremendous amounts of dietary fibre and antioxidants. Pomegranate peel is discarded considering as waste. The incorporation as PPP in the chapatti is a cost effective waste utilization method. Chemical analysis of PPP showed 26.6 g% of dietary fibre content and very high (81.6%) radical scavenging activity. The radical scavenging activity of chapatti goes on increasing with increase in concentration of PPP. The water absorption capacity (WAC) of flour increases with increase in concentration of PPP. For control it was 123.4% and it steadily increases to 166.5% for 10% PPP incorporation. The Dough colour test showed that brightness of dough goes on decreasing with increase in yellowness with increase in the concentration of PPP indicated by decrease in L* value and increase in b* value respectively. Dough stickiness test showed that stickiness of dough increases due to increase in the water holding capacity of flour with the addition of PPP. But, due to the simultaneous action of high quantities of dietary fibre present, the dough also looses its strength. Controlled amount of PPP incorporation, upto 5% will be helpful to increase the stickiness as well as maintaining the dough strength. Dough hardness test showed that just by incorporation of 5% PPP, the hardness can be reduced by 50%.The Scanning electron microscopy micrographs shows protein matrix, starch granules and fibrous structures in combination in chapatti with PPP incorporation whereas in case of control protein is seen either in association with starch granules or as clusters of storage protein. In sensory evaluation it was observed that as the level of PPP was increases sensory scores decrease significantly as compared to the control due to bitterness and pale yellow colour.

It is concluded that chapatti with 5% PPP incorporation can be considered fit for consumption. At 5% PPP incorporation the water holding capacity of flour is increased, stickiness of dough is increased, hardness of dough is reduced, and chapatti has relatively softer texture without any noticeable bitterness.

It is rich in dietary fibre, proteins, iron, calcium and antioxidants. Its incorporation results in increased water holding capacity of wheat flour thereby increasing softness and also antioxidants contribute in increasing shelf life of chapatti.

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