The Pharma Innovation Journal 2022; 11(5): 58-64

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(5): 58-64

www.thepharmajournal.com
Received: 07-02-2022
Accepted: 23-04-2022

Navpreet Kaur Dhillon
M.Sc. Student, Department of Food Science and Technology, Punjab Agricultural University, Ludhiana, Punjab, India

Barinderjeet Singh Toor
Ph.D., Scholar, Department of Food Science and Technology, Punjab Agricultural University, Ludhiana, Punjab, India

Amarjeet Kaur
Principal Food Technologist (Milling Technology), Department of Food Science and Technology, Punjab Agricultural University, Ludhiana, Punjab, India

Jaspreet Kaur
Food Technologist, Department of Food Science and Technology, Punjab Agricultural University, Ludhiana, Punjab, India

Corresponding Author:
Barinderjeet Singh Toor
Ph.D., Scholar, Department of Food Science and Technology, Punjab Agricultural University, Ludhiana, Punjab, India

Characterization and evaluation of yellow pea flour for use in '*Missi Roti*' a traditional Indian flat bread in comparison with *Desi* chickpea flour

Navpreet Kaur Dhillon, Barinderjeet Singh Toor, Amarjeet Kaur and Jaspreet Kaur

Abstract
A comparative analysis based on the nutritional, antinutritional, functional and pasting properties was performed between the yellow pea and *desi* chickpea flours. Results showed significantly ($p< 0.05$) higher ash, fiber and carbohydrate contents in yellow pea flour while protein and fat contents were higher in *desi* chickpea flour. The superior mineral, essential amino acid and antinutritional compositions as well as significantly ($p< 0.05$) higher antioxidant properties were observed in yellow pea flour. Functional properties revealed the yellow pea flour to possess higher ($p< 0.05$) water absorption capacity, swelling power, foam capacity and *in vitro* protein digestibility while *desi* chickpea flour showed higher ($p< 0.05$) bulk density, water solubility index, oil absorption capacity, emulsion capacity, emulsion stability and foam stability. In pasting properties, higher ($p< 0.05$) peak viscosity, trough viscosity, final viscosity and pasting temperature values were observed for yellow pea flour. Furthermore, *desi* chickpea flour was substituted with yellow pea flour at different levels (0-100%) in the *missi roti*, a traditional Indian flat bread, to investigate the effect on nutritional composition, color properties (L*, a*, b*) and sensorial attributes. Results demonstrated that the yellow pea flour could be used at 100% substitution level in the preparation of *missi roti* without affecting the sensory as well as nutritional quality. Conclusively, the present investigation showed the yellow pea flour to possess excellent nutritional, antioxidant and functional properties thus it can be utilized in the development of various healthy traditional and novel food products.

Keywords: *Desi* chickpea, functional properties, legumes, *Missi roti*, nutritional properties, yellow pea

1. Introduction

The gradual demographic growth, low economic resources and consumer health awareness create necessity to explore the animal protein substitutes. In such context, the plant foods especially legumes serve the purpose by providing the opportunity to food manufacturers to develop plant based protein enriched foods. The low glycemic index, gluten free status, significant antioxidant potential, high protein levels and complex carbohydrates as well as superior functional properties supplement the importance of legumes in addressing the nutritional security issues (Ettoumi and Chibane, 2015; Toor *et al*., 2022) [10, 25]. Moreover, previous investigations have associated the regular consumption of legumes with lower risk of cardiovascular diseases, metabolic syndrome, obesity and diabetes as well as enhanced insulin sensitivity (Setia *et al*., 2019) [23].

Legumes are the primary source of protein in the vegetarian diets. Although legume proteins have lower biological value ascribing to the lack of sulphur containing amino acids (cysteine and methionine), they contain high concentration of other important amino acids, for instance, lysine, phenylalanine and leucine (Boye *et al*., 2010) [6]. The combination of legumes with commonly consumed cereals such as rice and wheat serve balanced protein diets. Besides, legumes are the good source of dietary fiber, minerals, vitamins (especially B complex) and various bioactive compounds (Boye *et al*., 2010; Setia *et al*., 2019) [6, 23].

Legumes such as chickpeas, kidney beans and lentils have been the major topic of research for their potential utilization in the food products (Zafar *et al*., 2015) [27]. In recent years, the underutilized legumes like yellow pea have gradually gained attention attributing to their high production yields, lower energy requirement and aid in nitrogen fixation (Setia *et al*., 2019) [23]. Apart from possessing significant nutritional and functional properties, yellow pea consumption provides health benefits such as reduced risk of cancer, heart diseases and type-2 diabetes (Roy *et al*., 2010) [22].

Recent investigations have reported the utilization of yellow pea flour in the bakery goods and pasta products (Setia *et al*., 2019) [23]. The present study was aimed to compare the nutritional and functional characteristics of yellow pea and *desi* chickpea flours. Moreover, the utilization of yellow pea flour in the traditional foods has not been reported yet therefore it was substituted with *desi* chickpea flour in the preparation of *missi roti*, a popular traditional Indian food.

2. Materials and Methods

2.1 Raw materials

Desi chickpea seeds were procured from Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana, India. Yellow pea seeds and other raw materials were acquired from local market of Ludhiana.

2.2 Preparation of yellow pea flour: Yellow pea seeds were cleaned and soaked overnight in tap water at room temperature. The soaked seeds were manually rubbed to remove the hull and tray dried for 6 h at 50 ˚C. Thereafter, the dried seeds were grinded in domestic mill to prepare flour.

2.3 Preparation of *desi* chickpea flour

Seeds were cleaned and soaked overnight in tap water at room temperature followed by tray drying for 3.5 h at 50 ˚C. The dried seeds were further soaked for 3-5 min in warm water and manually dehulled. Thereafter, the dehulled seeds were tray dried for 4 h at 50 ˚C and milled to obtain flour.

2.4 Analysis of yellow pea and *desi* chickpea flours

2.4.1 Proximate composition

Moisture, protein, fat, ash, fibre and carbohydrates of yellow pea and *desi* chickpea flours were analyzed using standard AACC procedures (AACC, 2000) [1].

2.4.2 Antioxidant properties

Total phenolic content was analyzed using method of Singleton *et al*. (1999) [24] and the results were expressed as mg Gallic acid equivalents (GAE)/g dry matter. DPPH radical scavenging activity (%) was performed according to the method of Brand-Williams *et al*. (1995) [7].

2.4.3 Antinutrients

The methods described by Haug and Lantzsch (1983) [13] and AOAC (2005) [4] were used to analyze phytic acid (mg phytate/g) and tannins (mg catechin/g), respectively. Results were calculated on dry matter basis.

2.4.4 Mineral composition

Samples were digested with distilled nitric acid and perchloric acid (3:1) for 45 min at 90-95 ˚C. Minerals (mg/100g) were quantified using inductively coupled plasma optical emission spectrometry (ICP-OES) (iCAP 6300; Thermo Fisher Scientific, Waltham, MA, USA) (Özcan *et al*., 2013) [19].

2.4.5 Essential amino acid composition

Flour samples were hydrolyzed with 6M HCl for 24 h at 110 ˚C followed by analysis using HPLC system (Agilent Technologies, Wilmington, DE, USA) equipped with ZORBAX Eclipse plus-C18 column (4.6 × 150 mm, 3.5 µm, Agilent Technologies, Wilmington, DE, USA). Methionine was determined after oxidizing with performic acid (Naiker *et al*., 2020) [18]. Results were expressed as g/100g protein.

2.4.6 Functional properties

Bulk density (g/ml), water absorption capacity (g/g), water solubility index (%) and oil absorption capacity (g/g) were determined using the procedures described by Kaur *et al*. (2007) [14]. The method reported by Toor *et al*. (2022) [25] was used to measure swelling power (g/g). Emulsion capacity (%), emulsion stability (%), foam capacity (%) and foam stability (%) were analyzed using the methods reported by Elkhalifa and Bernhardt (2010) [9]. Akson and Stahman (1964) [3] method was utilized to determine *in vitro* protein digestibility (%).

2.4.7 Pasting properties

Rapid Visco Analyzer (RVA) starch master 2 (Newport Scientific Narrabean, Australia) was used for analyzing the pasting properties (Kaur *et al*., 2007) [14]. The parameters recorded were peak viscosity (cP), trough viscosity (cP), breakdown (cP), final viscosity (cP), setback (cP) and pasting temperature (˚C).

2.5 Missi roti preparation

The procedure reported by Pathania *et al*. (2017) [20] was utilized for the preparation of *missi roti* wherein whole wheat flour and *desi* chickpea flour were used in 50:50 ratio. In the present study, the *desi* chickpea flour was substituted with yellow pea flour at 0-100% levels. The recipe of *missi roti* and the different formulations (A-F) used are given in Table 1.

The flour blend and other ingredients were weighed and mixed thoroughly followed by kneading using optimum quantity of water. The dough formed after kneading was rested for 15 min. The dough ball, each weighing 40 g, was rolled into circular sheet using rolling pin. The dough sheet was baked on pan for 1-2 min and ghee was applied on both the sides.

Table 1: Recipe of *missi roti* supplemented with yellow pea flour

Ingredients (g)	Blends					
	A(Control) 0% YPF	B 20% YPF	C 40% YPF	D 60% YPF	E 80% YPF	F 100% YPF
Desi chickpea flour	50	40	30	20	10	0
Yellow pea flour	0	10	20	30	40	50
Whole wheat flour	50	50	50	50	50	50
Onion flakes	8	8	8	8	8	8
Ghee	4	4	4	4	4	4
Salt	2	2	2	2	2	2
Fenugreek seeds	2	2	2	2	2	2
Mango powder	1.4	1.4	1.4	1.4	1.4	1.4
Ginger powder	0.6	0.6	0.6	0.6	0.6	0.6

Green chilli powder	0.2	0.2	0.2	0.2	0.2	0.2
Red chilli powder	0.2	0.2	0.2	0.2	0.2	0.2
Glycerol monostearate	0.25	0.25	0.25	0.25	0.25	0.25
Sodium stearoyl lactylate	0.25	0.25	0.25	0.25	0.25	0.25

YPF - yellow pea flour

2.6 Sensory evaluation of *missi roti*
The sensorial evaluation of *missi roti* was performed by the panel of 15 semi-trained panelists on 9-point hedonic scale for color, flavor, taste, texture and overall acceptability.

2.7 Physicochemical analysis of *missi roti*
Proximate composition including moisture, protein, fat, ash and carbohydrates were analyzed using standard procedures (AACC, 2000) [1]. Color values (L*, a*, b*) were obtained using Hunter Lab Calorimeter (CR-300 Minolta Camera, Japan).

2.8 Statistical analysis
All the experiments were performed in triplicates (except essential amino acid composition) and results were presented as mean value ± standard deviation. The data sets obtained for yellow pea and *desi* chickpea flours, were subjected to t test at $p< 0.05$ significance level. In the experiments for *missi roti*, the variation among mean values was determined using one-way analysis of variance (ANOVA) at $p< 0.05$ significance level.

3. Results and Discussion
3.1 Analysis of yellow pea and desi chickpea flours
3.1.1 Proximate composition
A significantly ($p< 0.05$) higher contents of protein and fat were found in *desi* chickpea flour while ash, fibre and carbohydrates were higher ($p< 0.05$) in yellow pea flour (Table 2). Results demonstrated that both the flours contained considerably high concentration of protein (21.70-24.33%) which make them potential alternatives to animal protein in the human diet. These legume flours can also be utilized in the development of diets for the people suffering from cardiovascular diseases as well as atherosclerosis ascribing to their low fat content (Ettoumi and Chibane, 2015)[10].

Table 2: Proximate composition of yellow pea and *desi* chickpea flours (%)

	Yellow pea flour	*Desi* chickpea flour
Moisture	6.15 ± 0.10^b	8.87 ± 0.05^a
Protein	21.70 ± 0.20^b	24.33 ± 0.43^a
Fat	2.15 ± 0.10^b	4.23 ± 0.15^a
Ash	2.88 ± 0.04^a	2.02 ± 0.10^b
Fibre	4.83 ± 0.04^a	1.72 ± 0.03^b
Carbohydrates	67.12 ± 0.03^a	60.55 ± 0.71^b

Data is presented as mean±standard deviation. Values having different superscripts (a, b) differ significantly ($p< 0.05$) row wise

3.1.2 Antioxidant properties
Yellow pea flour (2.380 mg GAE/g) contained a significantly ($p< 0.05$) higher phenolic content compared to *desi* chickpea flour (1.490 mg GAE/g) (Fig. 1). A similar trend was observed for DPPH radical scavenging activity wherein yellow pea flour (21%) possessed considerably ($p< 0.05$) higher antioxidant activity than *desi* chickpea flour (14%) (Fig. 1). Agboola *et al*. (2010) [2] reported a strong correlation between phenolics and antioxidant activity attributing it to the electron donating ability of phenolic compounds that stabilizes reactive oxygen species and prevent the body from oxidative stress and related disorders (Xiao *et al*., 2015) [26]. Thus, the superior radical scavenging activity of the yellow pea flour might be ascribed to its higher phenolic content.

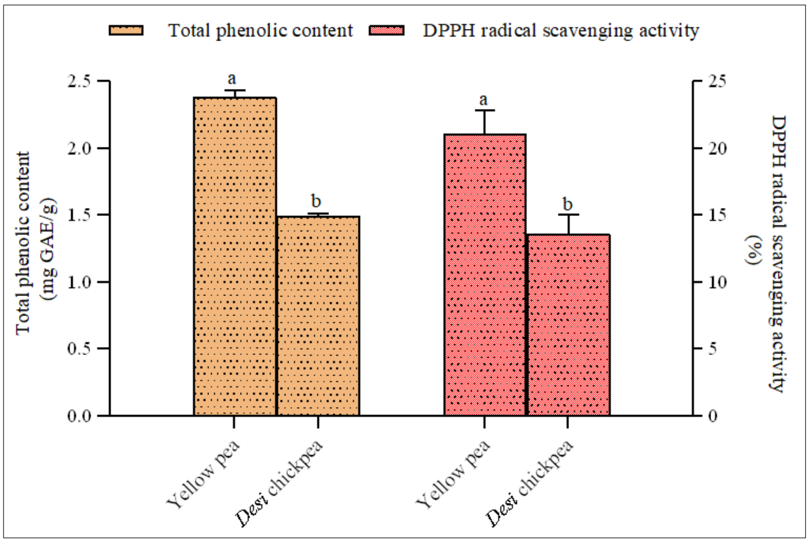

Fig 1: Antioxidant properties of yellow pea and *desi* chickpea flours. Error bars depicts the standard deviation of the means of three replicates. Different alphabets (a, b) on bars indicate significant difference ($p< 0.05$)

3.1.3 Antinutrients
Phytic acid and tannins were significantly ($p< 0.05$) higher in *desi* chickpea flour (7.61 and 3.57 mg/g, respectively) as compared to yellow pea flour (6.82 and 2.74 mg/g, respectively) (Fig. 2). In food matrix, the phytates bind the nutritionally essential divalent cations such as iron, zinc, calcium and magnesium. Such reactions results in the formation of insoluble complexes leading to the unavailability of these minerals for absorption and utilization (Ettoumi and Chibane, 2015; Zhao *et al*., 2017) [10, 28]. Therefore, it is

advised by European Food Safety Authority to elevate the zinc intake by 2-7 mg/day while consuming the food with high phytic acid levels to ensure the adequate bioavailability of zinc (Millar *et al*., 2019) [17]. Moreover, the tannins and phytic acid inhibit nutrients utilization through reduced forage digestibility, astringency and enzyme inhibition (Ettoumi and Chibane, 2015) [10]. Thus, the lower contents of antinutrients in yellow pea flour indicated better bioavailability of nutrients present in it.

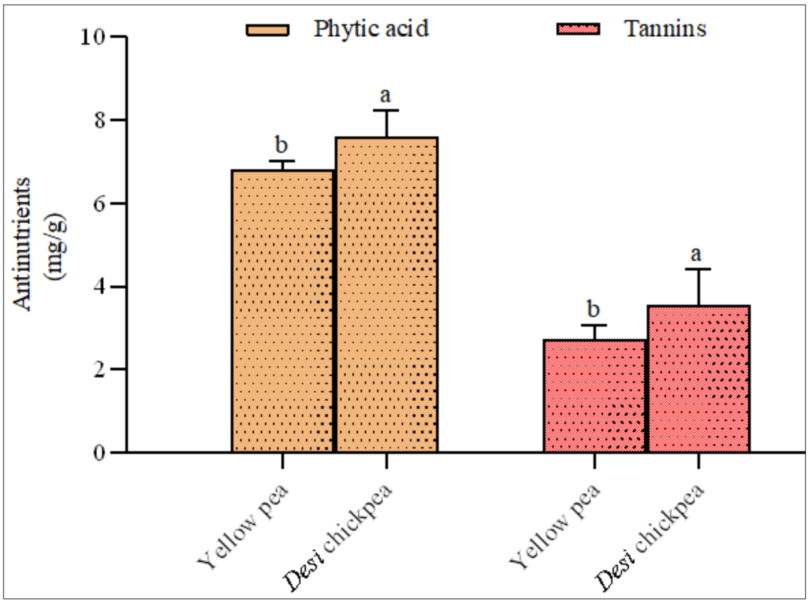

Fig 2: Antinutritional properties of yellow pea and *desi* chickpea flours. Error bars depicts the standard deviation of the means of three replicates. Different alphabets (a, b) on bars indicate significant difference ($p < 0.05$)

3.1.4 Mineral composition

Among the macrominerals, sodium and calcium were found to be higher ($p < 0.05$) in yellow pea flour while the phosphorus content was higher ($p < 0.05$) in *desi* chickpea flour (Table 3). The microminerals such as manganese, zinc, copper and iron were higher ($p < 0.05$) in yellow pea flour. Millar *et al*. (2019) [17] have reported the negative correlation between antinutrients and bioavailability of minerals (Zhao *et al*., 2017) [28]. Thus, the superior mineral composition of yellow pea flour might be attributed to the lower levels of antinutrients present in it. The higher levels of minerals in yellow pea flour is beneficial as they are utilized by the human body to execute numerous vital functions. For example, sodium retains the electrolyte balance; calcium and manganese aids in blood clotting; phosphorus provide assistance in cellular communication; iron plays important role in oxygen distribution (Gharibzahedi and Jafari, 2017) [11].

Table 3: Mineral composition of yellow pea and *desi* chickpea flours (mg/100g)

	Yellow pea flour	*Desi* chickpea flour
Sodium	187.40±1.21^a	120.71±1.64^b
Calcium	843.02±3.12^a	456.20±2.95^b
Phosphorus	205.71±1.74^b	243.61±1.11^a
Manganese	89.40±0.21^a	56.41±0.26^b
Zinc	13.12±0.54^a	8.39±0.48^b
Copper	3.95±0.29^a	1.82±0.21^b
Iron	21.42±1.01^a	18.89±0.37^b

Data is presented as mean±standard deviation. Values having different superscripts (a, b) differ significantly ($p < 0.05$) row wise

3.1.5 Essential amino acid composition

The contents of all amino acids except methionine were found to be higher in yellow pea flour than *desi* chickpea flour (Table 4). The results demonstrated the superior amino acid composition of yellow pea flour which could be due to the lower levels of antinutrients present in it, as these compounds can impair the bioavailability of protein moieties through complexation (Ettoumi and Chibane, 2015; Zhao *et al*., 2017) [10, 28]. In general, legumes are low in sulphur containing amino acids therefore they must be consumed in combination with cereals to provide optimum balance of essential amino acids.

Table 4: Essential amino acid composition of yellow pea and *desi* chickpea flours (g/100g protein)

	Yellow pea flour	*Desi* chickpea flour
Valine	2.44	1.39
Leucine	6.40	2.59
Isoleucine	3.60	1.23
Threonine	3.30	1.20
Methionine	1.20	2.33
Lysine	2.20	0.89
Phenyl Alanine	6.40	2.89
Histidine	2.33	0.96
Tryptophan	0.90	0.81

3.1.6 Functional properties

Table 5 shows the functional properties of yellow pea and *desi* chickpea flours. Water absorption capacity, swelling power, foam capacity and *in vitro* protein digestibility were significantly ($p < 0.05$) higher in yellow pea flour contrasted to *desi* chickpea flour. The higher water absorption capacity in yellow pea flour might be attributed to the surface predominance of polar amino acid residues of proteins that have greater affinity for water molecules (Ma *et al*., 2011) [16]. In addition, the hydrophilic components such as polysaccharides and soluble fiber might also contributed to the hydration capacity (Ettoumi and Chibane, 2015) [10]. The better foaming capacity in yellow pea flour might be ascribed to the higher charge on protein molecules that weakened the hydrophobic interaction. Thus, allowing the flour proteins to spread quickly on air-water interface and encapsulating more air particles (Ghavidel and Prakash, 2006) [12]. The swelling power of flour depicts the intensity of associative forces between the starch granules thus the higher swelling power in yellow pea flour showed the stronger associative forces in contrast to *desi* chickpea flour (Toor *et al*., 2022) [25]. The higher *in vitro* protein digestibility of yellow pea flour could be due to the lower levels of antinutrients present in it. As discussed earlier, these compounds have the ability to complex the protein molecules resulting in their poor bioavailability as well as digestibility (Drulyte and Orlien, 2019) [8].

Table 5: Functional properties of yellow pea and *desi* chickpea flours

	Yellow pea flour	*Desi* chickpea flour
Bulk density (g/ml)	0.52±0.02^b	0.63±0.003^a
Water absorption capacity (g/g)	2.75±0.02^a	1.74±0.01^b
Water solubility index (%)	1.61±0.04^b	2.26±0.24^a
Oil absorption capacity (g/g)	1.05±0.06^b	2.04±0.06^a
Swelling power (g/g)	3.77±0.02^a	3.42±0.02^b
Emulsion capacity (%)	36.76±0.04^b	39.01±0.44^a
Emulsion stability (%)	14.09±0.21^b	25.61±0.12^a
Foam capacity (%)	38.62±.14^a	35.74±0.10^b
Foam stability (%)	40.76±0.24^b	44.83±0.26^a
In vitro protein digestibility (%)	82.46±0.44^a	73.76±0.51^b

Data is presented as mean±standard deviation. Values having different superscripts (a, b) differ significantly (p< 0.05) row wise

Bulk density, water solubility index, oil absorption capacity, emulsion capacity, emulsion stability and foam stability were higher (p< 0.05) in *desi* chickpea flour as compared to yellow pea flour. The bulk density of flour describes its compactness, which influence the mouth feel as well as textural attributes of food products. The flours with high bulk density are easy to disperse while low bulk density flours have application in the development of infant foods (Toor *et al*., 2022) [25]. Water solubility index of yellow pea and *desi* chickpea flours considerably differed which is attributed to the disparity in the concentration of their soluble fractions. The oil absorption capacity of flour depends on the surface availability of hydrophobic amino acids. Thus, the higher oil absorption capacity in *desi* chickpea flour depicts the better availability of hydrophobic groups at the surface of proteins (Ma *et al*., 2011) [16]. The higher emulsion capacity in *desi* chickpea flour might be ascribed to the greater occurrence of protein-polysaccharide interactions forming a strong homogenous biopolymer film at the emulsion interfaces (Lam and Nickerson, 2013) [15]. Moreover, the higher emulsion and foam stabilities in *desi* chickpea flour could be due to the better availability of carbohydrates at the interface, which acted as bulky barrier between oil droplets thus preventing the rate of oil droplet coalescence.

3.1.7 Pasting properties

Yellow pea flour demonstrated significantly (p< 0.05) higher peak viscosity, trough viscosity, final viscosity and pasting temperature contrasted to *desi* chickpea flour (Table 6). Here, the peak viscosity is the maximum viscosity achieved immediately following cooking. It signifies the water holding capacity of flour as well as the strength of paste developed from gelatinization. Trough viscosity indicates the ability of paste to withstand high temperature conditions. The final viscosity defines the ability of flour to develop viscous as well as stable paste. Pasting temperature is the minimum temperature at which the viscosity begins to elevate. Higher pasting temperature values implies higher resistance to swelling and rupturing of starch granules. The significant difference in the defined pasting parameters of yellow pea and *desi* chickpea flours could be due to disparity in the molecular structure of starch granules (Awolu, 2017; Rincón-Londoño *et al*., 2016) [5, 21].

Table 6: Pasting properties of yellow pea and *desi* chickpea flours

	Yellow pea flour	*Desi* chickpea flour
Peak viscosity (cP)	1250.67±0.31^a	732.27±0.31^b
Trough viscosity (cP)	1160.60±0.36^a	617.73±0.38^b
Breakdown (cP)	89.83±0.35^b	113.27±0.25^a
Final viscosity (cP)	1854.80±0.30^a	905.17±0.40^b
Setback (cP)	695.33±0.15^a	287.37±0.45^b
Pasting temperature (˚C)	82.67±0.15^a	75.77±0.35^b

Data is presented as mean±standard deviation. Values having different superscripts (a, b) differ significantly (p< 0.05) row wise

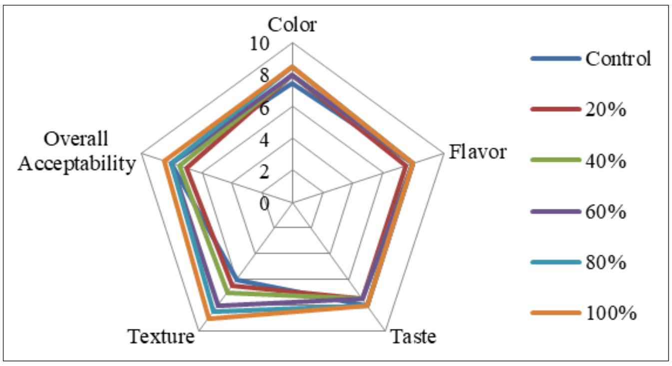

Fig 3: Sensory evaluation of *missi roti* supplemented with yellow pea flour

3.2 Sensory evaluation of *missi roti*

The sensory evaluation of *missi roti* prepared using different blends is demonstrated in Fig 3. A significant elevation in the sensory scores for texture attribute was observed with increase in the substitution levels of *desi* chickpea flour with yellow pea flour. This could be due to the higher water absorption capacity of yellow pea flour that imparts soft texture to the *missi roti.* However, the color, flavor and taste attributes meagerly changed with the substitution. Regarding overall acceptability, an insignificant difference was observed between the sample with 100% replacement and control. Conclusively, the *missi roti* (Fig 4) prepared with 100% levels of yellow pea flour was selected as best by the panelists.

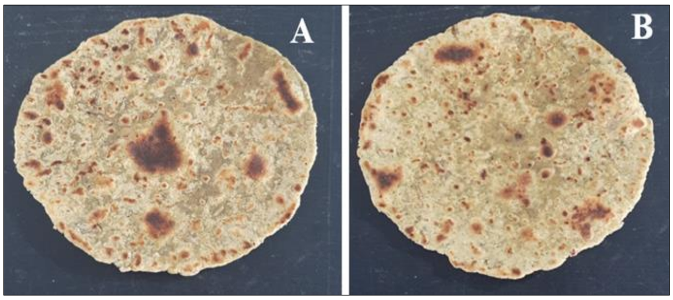

Fig 4: *Missi roti,* A – control sample; B – sample with 100% substitution of *desi* chickpea flour with yellow pea flour

3.3. Physicochemical analysis of *missi roti*

Table 7 demonstrates the physicochemical properties of *missi roti* prepared using different blends. Moisture content of *missi roti* increased from 22.08 to 30.20% with increase in the replacement level of *desi* chickpea flour with yellow pea flour. This might be attributed to the relatively higher water absorption capacity of yellow pea flour. The protein and fat contents varied from 15.86 to 16.99% and 7.31 to 9.93% respectively, with the highest values in control and lowest in sample with 100% replacement. This is ascribed to the higher protein and fat contents of *desi* chickpea flour compared to yellow pea flour. Further, the ash content increased while carbohydrates and calorific value decreased with increasing substitution levels. A considerable increment was observed in the L* and b* values with replacement which is attributed to the bright yellow color of the yellow pea flour.

Table 7: Physicochemical properties of *missi roti* supplemented with yellow pea flour

	A (Control) 0% YPF	B 20% YPF	C 40% YPF	D 60% YPF	E 80% YPF	F 100% YPF
Moisture (%)	22.08±0.01[f]	24.13±0.02[e]	26.07±0.02[d]	28.77±0.04[c]	29.48±0.06[b]	30.20±0.01[a]
Protein (%)	16.99±0.13[a]	16.82±0.04[b]	16.63±0.03[c]	16.54±0.01[c]	16.28±0.03[d]	15.86±0.07[e]
Fat (%)	9.93±0.07[a]	8.75±0.07[b]	8.51±0.06[c]	8.17±0.05[d]	7.70±0.06[e]	7.31±0.06[f]
Ash (%)	2.01±0.00[e]	2.08±0.00[e]	2.17±0.01[d]	2.24±0.05[c]	2.37±0.04[b]	2.49±0.02[a]
Carbohydrates (%)	48.99±0.18[a]	48.22±0.14[b]	46.63±0.05[c]	44.28±0.07[d]	44.18±0.12[d]	44.14±0.04[d]
Calorific value (Kcal/100g)	353	339	330	317	311	306
L*	43.95±0.07[f]	44.65±0.12[e]	45.77±0.18[d]	46.64±0.10[c]	47.38±0.04[b]	48.76±0.15[a]
a*	8.53±0.06[a]	8.07±0.07[b]	7.34±0.06[c]	6.46±0.06[d]	5.63±0.08[e]	5.03±0.08[f]
b*	31.74±0.24[e]	32.94±0.11[d]	34.52±0.18[c]	36.04±0.19[b]	36.26±0.08[b]	38.08±0.12[a]

Data is presented as mean±standard deviation. Values having different superscripts (a-f) differ significantly ($p < 0.05$) row wise. YPF – yellow pea flour

4. Conclusions

The present study demonstrated significant variations in the nutritional and functional attributes of yellow pea and *desi* chickpea flours. A considerably higher total phenolic content and radical scavenging activity were observed in yellow pea flour. Antinutritional properties showed higher phytic acid and tannins in *desi* chickpea flour. Furthermore, yellow pea flour exhibited superior mineral and essential amino acid compositions as well as *in vitro* protein digestibility. The *missi roti* prepared at 100% substitution level of *desi* chickpea flour with yellow pea flour was acceptable. Conclusively, yellow pea being an underutilized legume had improved nutritional, functional and antioxidant properties thereby can be utilized in the preparation of various traditional as well as novel functional foods that can help in reducing the risk of oxidative stress as well as lifestyle disorders.

5. Acknowledgements

We are grateful to the Department of Science and Technology for providing facilities to perform research activities under PURSE project – Phase II "Addressing Food Security through Nationally Enriched Improved Cultivars and Technologies for Swasth Bharat".

6. References

1. AACC. Approved methods of the American Association of Cereal Chemists. Edn 10, American Association of Cereal Chemists, USA, 2000.
2. Agboola SO, Mofolasayo OA, Watts BM. Aluko RE. Functional properties of yellow field pea (*Pisum sativum* L.) seed flours and the *in vitro* bioactive properties of their polyphenols. Food Research International. 2010;43:582-588.
3. Akson W, Stahman M. A pepsin–pancreatin digest index of protein quality. Journal of Nutrition. 1964;83(3):257-261.
4. AOAC. Official methods of analysis. Edn 18, Association of Official Analytical Chemists. USA, 2005.
5. Awolu OO. Optimization of the functional characteristics, pasting and rheological properties of pearl millet-based composite flour. Heliyon 2017;3(2):e00240.
6. Boye J, Zare F, Pletch A. Pulse proteins: Processing, characterization, functional properties and applications in food and feed. Food Research International. 2010;43(2):414-431.
7. Brand-Williams W, Cuvelier ME, Berset C. Use of a free radical method to evaluate antioxidant activity. LWT-Food Science Technology. 1995;28(1):25-30.
8. Drulyte D, Orlien V. The effect of processing on digestion of legume proteins. Foods. 2019;8(6):224.
9. Elkhalifa AEO, Bernhardt R. Influence of grain germination on functional properties of sorghum flour. Food Chemistry. 2010;121(2):387-392.
10. Ettoumi LY, Chibane M. Some physicochemical and functional properties of pea, chickpea and lentil whole flours. International Food Research Journal. 2015;22(3):987-996.
11. Gharibzahedi SMT, Jafari SM. The importance of minerals in human nutrition: Bioavailability, food fortification, processing effects and nano encapsulation. Trends in Food Science and Technology. 2017;62:119-132.
12. Ghavidel RA, Prakash J. Effect of germination and dehulling on functional properties of legume

flours. Journal of the Science of Food and Agriculture. 2006;86(8):1189-1195.
13. Haug W, Lantzsch HJ. Sensitive method for the rapid determination of phytate in cereals and cereal products. Journal of the Science of Food and Agriculture. 1983;34(12):1423-1426.
14. Kaur M, Sandhu KS, Singh N. Comparative study of the functional, thermal and pasting properties of flours from different field pea (*Pisum sativum* L.) and pigeon pea (*Cajanus cajan* L.) cultivars. Food Chemistry. 2007;104(1):259-267.
15. Lam RS, Nickerson MT. Food proteins: A review on their emulsifying properties using a structure–function approach. Food Chemistry. 2013;141(2):975-984.
16. Ma Z, Boye JI, Simpson BK, Prasher SO, Monpetit D, Malcolmson L. Thermal processing effects on the functional properties and microstructure of lentil, chickpea, and pea flours. Food Research International. 2011;44(8):2534-2544.
17. Millar KA, Gallagher E, Burke R, McCarthy S, Barry-Ryan C. Proximate composition and anti-nutritional factors of fava-bean (*Vicia faba*), green-pea and yellow-pea (*Pisum sativum*) flour. Journal of Food Composition and Analysis. 2019;82:103233.
18. Naiker TS, Baijnath H, Amonsou EO, Mellem JJ. Effect of steaming and dehydration on the nutritional quality and functional properties of protein isolates produced from *Lablab purpureus* (L.) Sweet (hyacinth bean). Journal of Food Processing and Preservation. 2020;44(2):e14334.
19. Özcan MM, Dursun N, Al Juhaimi F. Macro-and microelement contents of some legume seeds. Environmental Monitoring and Assessment. 2013;185(11):9295-9298.
20. Pathania S, Kaur A, Sachdev PA. Chickpea flour supplemented high protein composite formulation for flatbreads: Effect of packaging materials and storage temperature on the ready mix. Food Packaging. 2017;11:125-132.
21. Rincón-Londoño N, Vega-Rojas LJ, Contreras-Padilla M, Acosta-Osorio AA, Rodríguez-García ME. Analysis of the pasting profile in corn starch: Structural, morphological, and thermal transformations, Part I. International Journal of Biological Macromolecules. 2016;91:106-114.
22. Roy F, Boye JI, Simpson BK. Bioactive proteins and peptides in pulse crops: Pea, chickpea and lentil. Food Research International. 2010;43(2):432-442.
23. Setia R, Dai Z, Nickerson MT, Sopiwnyk E, Malcolmson L, Ai Y. Impacts of short-term germination on the chemical compositions, technological characteristics and nutritional quality of yellow pea and faba bean flours. Food Research International. 2019;122:263-272.
24. Singleton VL, Orthofer R, Lamuela-Raventós RM. Analysis of total phenols and other oxidation substrates and antioxidants by means of folin-ciocalteu reagent. Methods in Enzymology. 1999;299:152-178.
25. Toor BS, Kaur A, Kaur J. Fermentation of legumes with *Rhizopus oligosporus*: effect on physicochemical, functional and microstructural properties. International Journal of Food Science and Technology. 2022;57(3):1763-1772.
26. Xiao Y, Rui X, Xing G, Wu H, Li W, Chen X, *et al*. Solid state fermentation with *Cordyceps militaris* SN-18 enhanced antioxidant capacity and DNA damage protective effect of oats (*Avena sativa* L.). Journal of Functional Foods. 2015;16:58-73.
27. Zafar TA, Al-Hassawi F, Al-Khulaifi F, Al-Rayyes G, Waslien C, Huffman FG. Organoleptic and glycemic properties of chickpea-wheat composite breads. Journal of Food Science Technology. 2015;52(4):2256-2263.
28. Zhao HM, Guo XN, Zhu KX. Impact of solid state fermentation on nutritional, physical and flavor properties of wheat bran. Food Chemistry. 2017;217:28-36.