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Nutritional and Bioactive Properties of Composite Flour Made from Hempseed and Corn Silk for Formulation of Fibre and Protein Rich *Paratha*

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aim: This study aims to analyze Nutritional and Bioactive properties of a novel composite flour and *paratha* made from it, developed by incorporating hemp seed flour, corn silk flour, and chickpea flour alongside wheat flour, targeting the creation of a high-protein and high-fiber flour blend for food product formulations.
Study Design: A randomized experimental study was conducted to evaluate the functional and nutritional profile of the developed composite flour and *paratha* taking whole wheat flour as control.

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Methodology: Various ratios of hemp seed, corn silk, and chickpea flours were blended with whole wheat flour to make the composite flour. *Paratha*, a common shallow fried Indian flatbread, was prepared from the blend. Sensory evaluation of the *paratha* was conducted to find in addition to analyses of functional properties, proximate composition, dietary fiber content, in vitro protein digestibility, bioactive compounds, and fatty acid profiles of both flour blend and *paratha*.

Results: The composite flour demonstrated a higher water absorption capacity (179.63 ml/100g) than whole wheat flour (147.67 ml/100g). Proximate analysis revealed a crude protein content of 17.06% and crude fiber content of 7.81% in the composite flour, significantly exceeding than that of whole wheat flour. Total dietary fiber was recorded at 21.37 g/100g, with an in vitro protein digestibility of 76.70%. The total phenolic content was markedly higher in composite flour (223.51 mg GAE/100g) compared to whole wheat flour (49.82 mg GAE/100g). Sensory evaluation indicated that the *parathas* made from composite flour had acceptable taste and texture with superior nutritional profile.

Conclusion: The study successfully developed a composite flour with superior nutritional attributes, highlighting the potential of incorporating wild and underutilized plant resources in sustainable food production. This novel composite flour can be a valuable addition to diets, offering enhanced protein, fiber, and bioactive compounds compared to traditional wheat flour, particularly in the preparation of nutritious *parathas*.

Keywords: Bioactive compounds; composite flour; corn silk; functional properties; hempseed; In vitro protein digestibility; nutritional quality; paratha.

1. INTRODUCTION

Nature encompasses a vast array of edible plants, from the unassuming dandelion to the majestic pine nut. The wild flora represents a vast and largely untapped resource, offering a unique opportunity to integrate regenerative agriculture principles into food production. Unlike cultivated crops, wild plants often require minimal intervention and can be harnessed to create value-added products.

Formulation of composite flour is one of the methods that can utilize both waste agricultural produce and wild vegetation. Instead of relying solely on wheat, use of composite or mixed flours is more sustainable option. These flours are a combination of starches and other ingredients to partially replace wheat flour. According to the definition, “Composite flours are a mixture of flours from tubers rich in starch (e.g., cassava, yam, sweet potato) and/or protein-rich flours (e.g., soy, peanut) and/or cereals (e.g., maize, rice, millet, buckwheat), with or without wheat flour” (Chandra et al. 2015). They can be in blends of two or three types of flours (binary or ternary mixtures) made from various crops like soybean, gram, cassava, and others.

Composite flours offer a sustainable approach to food production by utilizing underutilized resources and agricultural-waste.

Hemp botanically known as *Cannabis sativa L*, is an annual plant. In India, it grows in wild area on its own, particularly in barren lands. In hilly regions, its seeds are consumed mostly as *chutney* or powder during winter season. However, in other parts of the country it is grown for pharmaceutical and narcotic purposes with the permission of government of India. The Indian Industrial Hemp Association (IIHA) received a license for the State Government of Uttarakhand in 2018 to cultivate hemp varieties with tetrahydrocannabinol (THC) level of less than 0.3%. Hempseed typically contains 20.40 percent protein and 27 percent fiber, insoluble fiber-rich carbohydrates (16.87%), polyunsaturated fatty acids (PUFA) and abundant fat (28.70%) (Singh et al. 2022).

Corn hair, also known as corn silk, is a byproduct of corn agriculture, consisting of the stigmas from the female flowers of the maize plant. It is characterized by its silky, thin, yellowish threads and a mildly sweet taste. Sweet corn silk contains considerable crude protein (16.19%) and crude fiber (16.11%). Dried corn silk powder contains phytochemicals, dietary fiber along with bioactive components like phenols, flavonoids, and antioxidants, which contribute significantly to human health (Singh 2021).

Chickpea (*Cicer arietinum L.*) stands as the primary legume crop in the diets of individuals across various regions worldwide, notably in African and Asian countries. Its dry seeds are predominantly consumed owing to their rich nutritional profile, particularly their protein content. Chickpeas serve as an exceptional nutrient source with 17%–22% protein, 3.82% crude fiber, they typically contain higher levels of zinc, phosphorus, and manganese compared to other legumes (Mansoor et al. 2021).

This research aims at development of novel composite flour for food product formulations. It also anticipates development of common food product (*paratha*) from different ratios of ingredients in composite flour and comparative analysis between product made from composite flour and whole wheat flour based on nutritional parameters. This study investigates the development of a novel composite flour by incorporating hemp seed flour, corn silk flour, and chickpea flour alongside wheat flour. An effort has been made to develop high protein and high fibre composite flour using these ingredients where hempseed and chickpea flour is for protein and corn silk powder is for fibre.

2. MATERIALS AND METHODS

In the development of high-protein and high-fibre food products, a novel flour blend incorporating hemp seed flour, chickpea flour, and corn silk powder was explored for its potential integration into whole wheat flour. It was hypothesized that these flours could significantly increase the nutritional profile without compromising sensory attributes. Four formulations were evaluated as shown in Table 1, one of which was control (100% whole wheat flour) along with three blends with different ratios of the ingredients.

Paratha, a common breakfast food was prepared. Flour blends and other ingredients mentioned in Table 1 were mixed and dough was prepared using water to a uniform consistency. The dough was then covered with a cotton cloth and left to rest for half an hour. After resting, the dough was divided into smaller pieces of equal size. Each piece was rolled out into a thin cake, smeared with oil, and folded twice to form a triangle. The resulting dough triangles were shallow fried on a heated pan for about five minutes. A semi-trained panel scored the sensory characters of all the products across all the categories using the score card (Larmond 1977) and scores were analysed using statistical test of one-way ANOVA.

Functional properties of selected flour blend were determined including water absorption capacity and oil absorption capacity using the method given by Lin et al. (1974). Bulk density was determined by method given by Narain et al. (1978).

Proximate composition of the product and the selected blend of composite flour were determined using the AOAC standard technique (AOAC 2010). The dietary fibre was estimated using the method given by (Asp and Johansson, 1981) *In vitro* protein digestibility was estimated by the procedure given by (Akeson and Stahman 1964). Total phenolic content (TPC) was determined using Folin-Ciocalteu's reagent as reported by (Singleton, et al., 1999). The total antioxidant activity was determined by DPPH (2.2-Diphenyl-1- picrylhydrazyl) radical scavenging activity (Williams et al., 1995). α-tocopherol content in composite flour was analysed using method of Emmerie and Engel (1938).

Table 1. List of ingredients for *paratha*

Ingredients	Control	Blend 1	Blend 2	Blend 3
Wheat flour(g)	100	60	50	40
Hemp seed flour(g)	-	15	20	25
Chickpea flour(g)	-	15	20	25
Corn silk powder(g)	-	10	10	10
Water(ml)	80	70	70	70
Oil(ml)	8	5	5	5
Salt(g)	1	1	1	1
Spices(g) (Carom & Niger seeds)	2	2	2	2
Total cooked weight (g)	158	156	154	154
No. of servings	4	4	4	4
Weight per serving(g)	39.5	39	38.5	38.5

The fatty acid composition was conducted at Pt. Deen Dayal Upadhyaya Veterinary Science University and Cattle Research Institute, Uttar Pradesh, India. A 2 g composite flour sample was digested with 10 ml concentrated HCl and 5-10 ml liquid ammonia in a hot water bath at 85°C for 1-1.5 h. After cooling, 50 ml petroleum ether and 5-10 ml ethanol were added. The mixture was transferred to a separating funnel, shaken, and washed with salt water to isolate the fat layer. The fat was mixed with 2 ml hexane, centrifuged, and stored in vials. The samples were analyzed for fatty acid profile using gas chromatography (Shimadzu CG-2014) with a capillary column (SH-RTX 2560).

3. RESULTS AND DISCUSSION

Sensory evaluation of fresh *paratha* was done using score card method (Table 2). Critical difference among paratha made by different blends was analyzed using one way ANOVA. It came out that control was significantly different and statistically classified as very good. Blend 1 and Blend 2 were statistically same, however Blend 3 is different in taste, flavour and overall acceptability. The reason for selection of Blend 2 was that it had similar sensory score to that of Blend 1, but Blend 2 had higher protein due to large amount of hemp seeds and chickpea seeds. Laboratory analysis was done on Blend 2 flour and *paratha* and whole wheat flour as control.

3.1 Functional Properties of Composite Flour

The water absorption capacity of composite flour was determined to be 179.63 ml/100g which is higher than that of whole wheat flour (147.67 ml/100g). A high water absorption capacity (WAC) of composite flours indicated that combining different flours can be beneficial in creating a variety of foods like dairy free processed cheese, bakery items, sausages, and dough. Flours with high water absorption are likely to contain more hydrophilic components such as polysaccharides. Chandra et al. (2015) observed that the water absorption capacity varied from 132 to 176% for composite flour, suggesting that the addition of rice, green gram, and potato flour influenced the amount of water absorbed by wheat flour. Singh et al. (1996) also observed that dough containing soy flour exhibited increased water absorption, likely due to the higher soluble protein content and water-binding properties of soy flour.

The study measured the Oil Absorption Capacity (OAC) of the composite flour, finding it to be 99.15 ml/100 g.The OAC of whole wheat flour was found to be 125.44 ml/100g. The reduced OAC is due to presence of high fat content hempseeds. Plantain flour absorbs the most oil, at 129.73 ml/100g, while tiger nut flour absorbs the least, at 71.62 mg/100g (Padilla et al. 1996). The presence of high-fat content in flours might have affected the oil absorption capacity (OAC) of the composite flours adversely (Chandra et al. 2015). In this case the fat content of hempseed (28.7%) can be responsible for decreased OAC in composite flour (Singh 2021).

The bulk density of the composite flour was 0.77 g/ml which was more than the bulk density of whole wheat flour of 0.72 g/ml. High bulk density requires less storage and transport volume. Bulk density of composite flour increased with an increase in the incorporation of different flours with wheat flour. Du et al. (2014) examined the bulk density of whole flours from various legumes. The findings indicated that the bulk density of these legume flours ranged from 0.543 g/ml to 0.816 g/ml, with lentil flour having the highest bulk density and black bean flour having the lowest.

Table 2. Mean scores for organoleptic acceptability of *Paratha* (n=30) using score card method

Parameters (*Paratha*)	Control (C)	Blend1 (B1)	Blend2 (B2)	Blend3 (B3)	CD (p=0.05)
Colour	9.01±0.63	8.11±0.63	8.43±0.73	8.33±0.64	0.338
Taste	8.68±0.64	8.04±0.87	8.25±0.99	7.45±1.05	0.459
Texture	8.85±0.73	7.96±0.69	8.11±0.70	7.81±0.82	0.374
Flavour	8.60±0.74	7.88±0.94	8.00±0.95	7.30±0.81	0.440
Overall acceptability	8.76±0.62	8.05±0.86	8.25±0.87	7.61±0.79	0.402

Valuesaremean ±standarddeviationofthirtyobservations; C:100:00:00:00;B1:60:15:15:10;B2:50:20:20:10;B3:40:25:25:10; Pointscale:1-2verypoor,3-4poor,5-6fair,7-8good,9-10very good

Table 3. Functional properties of whole wheat flour and composite flour

Flour Properties	WWF	CF	(p=0.05)
Water absorption capacity (%)	147.67±1.91	179.63±1.23	
Oil absorption capacity (%)	125.44±0.59	99.15±0.65	
Bulk density (g/ml)	0.72±0.01	0.77±0.01	

All values are mean± standard deviation of three replicates WWF: Whole Wheat Flour, CF: Composite Flour

3.2 Proximate Composition of Composite Flour

Table 4 depicts proximate composition of the composite flour. The moisture content of composite flour on as is basis was 6.42 per cent whereas for whole wheat flour, the it was found to be 10.85%. A significant difference (p=0.05) was observed among the moisture values of whole wheat flour and composite flour.

For composite flour, the total ash content was determined to be 3.48% whereas whole wheat flour exhibited a total ash content of 1.92%. Wheat flour ash content values were slightly higher than the value 1.33% reported by Bhat et al. (2016). Higher ash content values highlights the superior mineral profile of composite flour than that of wheat flour.

Composite flour, with 17.06% crude protein, was identified as a good protein source as it has more than 10% of RDA per 100 g for solids. Kulkarni and Sakhale (2018) found 10.02% protein content in millet-based multigrain flour. Whole wheat flour's crude protein content was found to be 11.46%, which is higher than the 9.8% reported by Akubor and Badifu (2004). For composite flour, the crude fat content was 7.30%.

The high crude fat content (7.30±0.18) in composite flour can be attributed to the significant oil content in hemp seeds. Whole wheat flour was found to have a crude fat content of 2.16%. The present study found a significant difference (p=0.05) in crude fat content between whole wheat flour and composite flour.

The crude fiber content in composite flour was found to be 7.81%, which was more than double the crude fibre content of whole wheat flour i.e. 3.20%. Millet-based multigrain flour with varying millet ratios had crude fiber content ranging from 1.80% to 3.10% (Akubor & Badifu 2004). The inclusion of whole hemp seed flour, chickpea flour, and corn silk powder in the composite flour contributed to its higher crude fiber content compared to whole wheat flour. The present study found a significant difference (p=0.05) in crude fiber content between the whole wheat flour and composite flour. With this findings the composite flour can be claimed as high fibre food ingredient (Food Safety and Standards 2018).

The carbohydrate content of composite flour was estimated to be 64.25%. Whole wheat flour was found to have a carbohydrate content of 81.26%. Kulkarni and Sakhale (2018) found higher

Table 4. Nutritional and anti-oxidant composition of composite flour and whole wheat flour

Parameters	Composite Flour	Whole Wheat Flour	CD (P=0.05)
Moisture (%)	6.42±0.38	10.85±0.13	NS
Total ash (%)	3.48±0.08	1.92±0.06	
Crude protein (%)	17.06±0.53	11.46±0.32	
Crude fat (%)	7.30±0.18	2.16±0.24	
Crude fibre (%)	7.81±0.27	3.20±0.27	
Carbohydrate (%)	64.25±0.16	81.26±0.86	
Physiological energy (Kcal/100g)	391±1.35	390±0.06	
Soluble dietary fibre (g/100g)	2.78±0.10	1.41±0.13	(p=0.05)
Insoluble dietary fibre (g/100g)	18.58±0.70	9.16±0.18	
Total dietary fibre (g/100g)	21.37±0.79	10.58±0.31	
Total phenol content (mg GAE/100g)	223.51±0.0.87	26.82±0.33	
DPPH% inhibition	75.24±0.07	36.32±0.79	

All value saremean ± standard deviation of thre ereplicates on dry weight basis NS: non-significant; p=0.05: significantly different carbohydrate values at 71.40% for millet-based multigrain flour. A significant difference (p=0.05) was observed in the carbohydrate content between the two samples of composite flour and wheat flour.

The physiological energy content of whole wheat flour was found to be 390 kcal/100g, which higher than the 372.90 Kcal/ 100g reported in literature (Akubor & Badifu 2018).

3.3 Dietary Fibre Content of Composite Flour

A significant difference (p=0.05) was found in the total dietary fiber (TDF) values of whole wheat flour and composite flour. In the present study, the TDF concentration for composite flour was determined to be 21.37 g/100g which is more than double the value of whole wheat flour. The TDF content in whole wheat flour was 10.58 g/100g, which is less than the values 11.36 g/100g reported by Longvah et al. (2017). Whole wheat flour's soluble dietary fiber (SDF) level was 1.41 g/100g, consistent with the 1.40 g/100g found by Ragaee et al. (2001). The insoluble dietary fiber (IDF) content in whole wheat flour was 9.16 g/100g.

3.4 *In vitro* Protein Digestibility (IVPD) of Composite Flour

The present study, the IVPD for composite flour was found to be 76.70%. The calculated IVPD value for whole wheat flour is 71.11%. Pradeep et al. (2014) reported an IVPD of 87% for a millet and legume-based multigrain ready-to-eat snack mix. The lower IVPD value for composite flour compared to some other reported values can be attributed to its higher dietary fiber content. The present investigation reported 21.37 g/100g of dietary fiber composite flour compared to 11.36 g/100g in whole wheat flour. Higher dietary fiber content is linked to obstructed protein hydrolysis because dietary fiber can increase the viscosity of digestive tract contents, preventing hydrolytic enzymes from accessing their substrates for hydrolysis, thereby lowering protein digestibility. However, the protein in hemp seed is primarily composed of high-quality, readily digestible proteins called edestin and albumin, which are rich in essential amino acids. This composition makes hemp seed protein suitable for consumption by both humans and animals (Wu et al. 2009).

3.5 Bioactive Compounds of Composite Flour

In the composite flour, the Total Phenolic Content (TPC) was found to be significantly higher at 223.51 mg Gallic acid equivqlent (GAE)/100g. In the present study, TPC of whole wheat flour was measured at 49.82 mg GAE/100g. In contrast, Li et al. (2015) reported a substantially higher TPC value of 74.47 mg GAE/100g for whole wheat flour.

Composite flour exhibited a significantly higher DPPH (2,2-diphynyle-1-picrylhydrazyle) inhibition of 75.24%, similar to the range of 75.2% to 86.2% reported by Itagi and Singh (2012) for millet-based multigrain composite mixes. In contrast, wheat flour showed a DPPH inhibition of 36.32%.

3.6 Fatty Acid Profile of Composite Flour

Table 5presents the analysis of fatty acids in composite flour that revealedthe presence of two saturated fatty acids (methyl stearate and methyl arachidate), one monounsaturated fatty acid (methyl cis-10-pentadecenoate), four polyunsaturated fatty acids, and one trans fatty acid were identified. The total fatty acid content in composite flour was found to be 7.8%. This included 0.24% saturated fatty acids, 0.74% monounsaturated fatty acids, and 5.46% polyunsaturated fatty acids. Additionally, 1.33% trans-fat was present. Omega-3 fatty acids were not detected, whereas omega-6 fatty acids constituted 5.46% of the total fatty acids.

The primary difference between composite flour and wheat flour lies in the diversity and concentration of fatty acids. Wheat cultivars contain a higher proportion of saturated and monounsaturated fatty acids compared to composite flour. The fatty acid profile of wheat cultivars, as analyzed by Zengin et al. (2017) revealed the presence of 20 individual fatty acids, ranging from C 10:0 to C 21:0. There was variation among the wheat cultivars in the total content of saturated fatty acids (SFA), which ranged from 37.76% to 45.20%, monounsaturated fatty acids (MUFA) from 18.33% to 22.03%, and polyunsaturated fatty acids (PUFA) from 32.77% to 43.41%. The dominant fatty acids in wheat are more concentrated, with oleic and linoleic acids being particularly prevalent. On the other hand, composite flour has a more varied profile with a

Table 5. Type and amount of different fatty acids in composite flour

S No.	Name	Type	Area (In %)
1	Methyl Penta deccenoate	MUFA	9.587
2	Methyl Linolenate	PUFA	70.108
3	MethylEicosadienoatecis11,14		
4	cis-13,16-Docosadienoicacidmethylester		
5	Methyl Linoleate		
6	Methyl Stearate	SFA	3.170
7	Methyl Arachidate		
8	Methyl Octadecenoate	TFA	17.135
		Total	100.00

higher proportion of polyunsaturated fatty acids and a notable presence of trans fats.

3.7 Proximate Composition of Composite Flour *paratha*

In the present study, control *paratha* had significantly higher moisture content of 23.67% than the moisture content of 19.32% observed for composite flour *paratha*. Higher the moisture content lower will be the nutrient density as well as storage stability of the product. The lower moisture content of composite flour *paratha* could be attributed to higher protein content of hemp seed and chickpea flour and could be correlated with the increased fat content due to whole hemp seed flour substitution.

Total ash, crude protein, crude fat and crude fibre content was more in composite flour *paratha* than that of whole wheat *paratha* (Table 6). Hemp seeds are nutritionally rich than whole wheat flour (Singh et al. 2022) therefore, *paratha* made out of composite flour has relatively higher amount of ash content, high crude protein and high crude fat content than the paratha made by using whole wheat flour. Further, high fibre content of paratha was due to high crude fibre in corn silk added in composite flour. The difference in proximate content of composite flour *paratha* and whole wheat flour *paratha* were significant at P=0.05. Similar results are reported by other scientists (Sharma & Prabhasankar 2021, Rusu et al. 2021).

In the present study, control *paratha* had significantly higher carbohydrate content of 81.26% compared to the carbohydrate content of 64.25% observed for composite flour *paratha*. This could be attributed to the presence of hemp seed and chickpea in the composite flour *paratha* since both of these flours have significantly lower carbohydrate content than the whole wheat flour. Reduction in carbohydrate content, indicates either higher amounts of protein or fat. Higher amount of protein is good for the diabetic diet.

Significant difference was observed in the physiological energy value of composite flour *paratha* (406.50 Kcal/100g) with control *paratha* (415.88 Kcal/100g).

The dietary fibre content of control *paratha* and composite flour *paratha* has been presented in Table 6. The total dietary fibre content including soluble and insoluble fractions was significantly higher in composite flour *paratha* which is directly associated with the higher dietary fibre content of hemp seed, corn silk and chickpea than whole wheat flour. The composite flour *paratha* were analysed to have TDF, SDF and IDF content of 14.71, 2.75 and 11.95 g, respectively whereas control *paratha* contained 6.91 g TDF, 0.85 g SDF and 6.05 g of IDF content. Hemp seed flour was used to make chapati by Sharma and Prabhasankar (2021). The results showed that the hemp seed flour chapati had 18.29, 2.63, and 15.66 g of TDF, SDF, and IDF, respectively, while the control had 11.78 g TDF, 2.46 g SDF, and 9.32 g of IDF content.

3.8 *In vitro* protein digestibility (IVPD) of Composite flour *paratha*

In the present study, the IVPD value of composite flour *paratha* was estimated as 74.72% which was significantly higher than the IVPD of 64.98% observed for control *paratha*. Due to the absence of gluten protein in hemp seed and chickpea flour, composite flour *paratha* may have a greater IVPD. The wheat protein gluten in control *paratha* may be the cause of their much lower IVPD value because it resists enzymatic hydrolysis due to the presence of proline components. Similar to the present study,

Table 6. Nutritional and anti-oxidant composition of composite flour and whole wheat flour *paratha*

Parameters	**Composite flour *paratha***		**Control *paratha***		**CD (P=0.05)**
	DWB*	**AIB****	**DWB**	**AIB**	**(p=0.05)**
Moisture*(%)	-	19.32±0.21	-	23.67±0.35	
Total ash (%)	3.99±0.14	3.22±0.10	2.57±0.20	1.96±0.15	
Crude protein (%)	16.36±0.39	13.19±0.35	15.28±0.46	11.67±0.34	
Crude fat (%)	11.02±0.40	8.89±0.30	7.69±0.25	5.87±0.18	
Crude fibre (%)	8.15±0.34	6.57±0.26	3.08±0.22	2.35±0.16	
Carbohydrate (%)	60.48±0.30	48.79±0.53	71.37±0.11	54.48±0.32	
Physiological energy (Kcal/100g)	406.50±0.22	327.58±0.95	415.88±1.84	317.43±0.33	
Soluble dietary fibre(g/100g)	2.75±0.17		0.85±0.07		
Insoluble dietary fibre(g/100g)	11.95±0.18		6.05±0.03		
Total dietary fibre(g/100g)	14.71±0.35		6.91±0.08		
Total phenol content(mg GAE/100g)	57.42±1.10		64.88±6.47		NS
DPPH% inhibition	56.95±0.72		99.41±0.68		(p=0.05)

All values are mean ± standard deviation of three replicates;= dry weight basis **= as is basis*

Table 7. Type and amount of different fatty acids in composite flour *paratha*

S.No.	Name	Type	Area (In %)
1	Methyl Pentadeccenoate	MUFA	69.609
2	Methyl Palmitoleate		
3	Methyl Heptadecenoate		
4	Methyl Oleate		
5	Methyl Linolenate		
6	Methyl Linoleate	PUFA	20.359
7	Methyl Eicosadienoatecis 11,14		
8	cis-8,11,14-Eicosatrienoicacid methyl ester		
9	cis-13,16-Docosadienoicacid methyl ester		
10	Methyl Tridecanoate	SFA	9.416
11	Methyl Arachidate		
12	Methyl behenate		
13	Methyl Linolelaidate	TFA	0.618
		Total	100.00

with a 30% substitution of whole wheat flour with whole hemp flour, whole hemp flour chapati reported a dramatic 85% of rise in the IVPD value (Sharma & Prabhasankar 2021). It suggests that addition of hemp seed, chickpea seeds has enhanced IVPD of the composite flour *paratha.* Amino acid content of pulses is always complementary to the cereal amino acid content.

3.9 Bioactive Compounds of Composite Flour *paratha*

In the present study, the TPC of hemp seed incorporated composite flour *paratha* was estimated as 64.88 mgGAE/100g while for the control *paratha* the amount was observed as 57.42 mgGAE/100g (Table 6). As expected, the TPC values were higher for composite flour *paratha* due to addition of hemp seed and corn silk as they possess very high phenolic content. Addition of spices such as carom and Niger seed also enhances the total phenolic content of the developed product. The DPPH % inhibition activity of the hemp seed-supplemented composite flour *paratha* was recorded at 99.47%, while the control *paratha* showed 56.95%. The significantly higher antioxidant activity in the composite flour *paratha* can be attributed to the enhanced radical scavenging properties of hemp seed, corn silk powder, and the added spices like *Trachyspermum ammi* (carom seeds) which is a potent source of natural antioxidant (Ishtiaque et al. 2014).

3.10 Fatty Acid Profile of Composite Flour *paratha*

Analysis of fatty acids in composite flour *paratha* revealed that there were thirty-seven fatty acids that were present during the analysis of the sample. Four saturated fatty acids, three monounsaturated, five polyunsaturated and one trans fatty acid were identified. The total percent of fatty acid in composite flour *paratha* was found to be 7.80 percent, out of which the percentage of saturated fatty acid was found to be 0.73 percent, 5.42 percent of monounsaturated fatty acid and 1.58 percent of polyunsaturated fatty acids was also reported during the study. 0.04 percent of trans fat was also found to be present in composite flour. The amount of omega 6 fatty acid was found to be 1.58 percent. With this composition of fatty acids the composite flour *paratha* can be labeled as a food product free from trans-fat and low in saturated fats (Food Safety and Standards 2018).

The decrease in trans fatty acids from composite flour (1.33%) to the final *paratha* (0.04%) is likely due to a combination of factors including interaction with other ingredients, fat redistribution and addition of water.

4. CONCLUSION

The exploration and development of composite flour incorporating hemp seed flour, corn silk flour, and chickpea flour presents a promising avenue for enhancing the nutritional profile of food products while promoting sustainability in food production. The findings of this study highlight the potential benefits of using underutilized resources and agricultural byproducts, such as hemp seeds and corn silk, to create value-added products.

The incorporation of these flours into whole wheat flour resulted in a novel composite flour blend that significantly improved the protein, fiber, and bioactive compound content of the resulting food products. The developed *paratha*, made with the optimal blend of 20% hemp seed flour, 20% chickpea flour, and 10% corn silk powder, demonstrated superior nutritional qualities compared to the control made from 100% whole wheat flour with higher protein, crude fiber and ash content contributing to enhanced nutrient density and storage stability.

The composite flour itself exhibited significantly better nutritional properties compared to whole wheat flour. It had higher protein, crude fiber, crude fat and lower carbohydrate content. The composite flour's total dietary fiber was also higher and it showed improved in vitro protein digestibility. Bioactive compounds analysis revealed a higher total phenolic content and stronger antioxidant activity. The fatty acid profile indicated a favourable composition with notable levels of polyunsaturated fatty acids. Functional properties such as water absorption capacity and bulk density were superior, making it suitable for diverse food applications.

The research demonstrates that the present composite flours not only offer a sustainable alternative to traditional wheat flour but also enhance the nutritional value of food products. This innovative approach to food production aligns with regenerative agriculture principles addresses nutritional deficiencies and promoting healthier dietary practices. Future research should focus on the long-term health impacts of consuming composite flours and explore their applications in a wider range of food products. Additionally, scaling up the production and commercialization of such composite flours could further advance sustainable food practices.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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