



Development of Maize based Composite Flour *Cheela* and its Effect on Nutritional, Sensory Characteristics and Quality Parameters

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ABSTRACT

Background: Malnutrition is most devastating problem among children and adults in India. Maize is the source of cheapest nutrients though its nutritional quality strengthened with combination of other food materials.

Methods: The experimental study was conducted in the year 2020-21 in the laboratory of Department of Food and Nutrition, Dr. RPCAU. The grains like flaxseed, chickpea, wheat, barley and ragi were selected for the study which was procured from local market of Pusa. These grains were undergone different processing methods viz. soaking, boiling, roasting and oven drying.

Result: The result showed that bulk density ranged from 0.52 to 0.65 g/ml. Moreover dimension varied from 153.54 cm² to 226.54 cm². Nutritional composition such as energy ranged from 375.06 kcal to 387.76 kcal, protein 6.42 to 19.36 g/100 g, fat 6.58 to 15.28 g/100 g, dietary fibre 16.91 to 25.70 g/100 g, carbohydrate 43.21 to 67.80 g/100 g, calcium 92.58 to 150.96 g/100 g, iron 4.28 to 7.05 mg/100 g and zinc 2.90 to 3.79 mg/100 g respectively. Therefore, treatment T₀E_{0.1} was overall acceptable.

Key words: Cheela, Composite flour, Maize, Malnutrition.

INTRODUCTION

In the modern era people are consuming and prefer fast food. However, fast food is made from refined flour. Although refined flour is not good for health (Shipra *et al.*, 2017). Cheela is staple food prepared from flour batter and additional ingredients. The composite flour product contains combination of different ingredients such as maize, flaxseed, chickpea, finger millet and barley with a better nutritional profile and therapeutic properties to reduce incidence of various lifestyle diseases. Composite flour used either binary or tertiary mixture of flours from some other crop with or without wheat flour (Noorfarahzilah *et al.*, 2014). Nutritionally balanced food at affordable cost is a prime concern in attaining food and nutritional security among population in the world (Bamidele and Fasogbon, 2020). Globally, maize is one of the third most important cereal crop after rice and wheat. However, maize is the most multi-skilled emergent crop which is widely accepted under various agro-climatic environments. Maize crop demands lesser water content as compared to other cereal crops. Among the maize growing countries, India rank 4th in area and 7th in production which represent 4 per cent of world maize area and 2 per cent of total production (IIMR, 2017). Maize is a source of nutrition as well as phytochemical compounds. Moreover, it helps to prevent chronic diseases due to presence of major phytochemicals present in maize such as carotenoids, phenolic compounds and phytosterols (Rouf Shah *et al.*, 2016). Flax seed is a promising alternative to reduce the risk of diseases associated with body weight excess because it is rich in alpha-linolenic acid, ligands and dietary fiber (Machado *et al.*, 2015). Flax seed is a globally important agricultural crop

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grown both for its seed oil and its stem fibre (Herchi *et al.*, 2015). Flaxseed is emerging as an important functional food ingredient (Katte *et al.*, 2024). Among the different legumes chickpea is categorized one of the oldest and most widely consumed legumes in the world as well as it is a staple food crop particularly tropical and sub-tropical region (Olika *et al.*, 2019). Chickpea can be used to develop nutritionally value added products and hence products can be used as nutritious for low income group people and for patients suffering with lifestyle diseases (Hirdyani, 2014). Chickpea is a good source of carbohydrate and proteins, which together constitutes about 80 per cent of the total dry seed mass. The starch content of chickpea cultivators have been reported to vary 41 to 50 per cent (Jambunathan and Singh, 1980). The unavailable carbohydrate content in chickpea is higher than any other legumes moreover; carbohydrate has a lower digestibility than other pulses (Kamath and Belavady, 1980). Barley is a major food and animal feed crop whereas, the nutrient content of barley compares favorably with that of corn, oats, wheat and field

peas. Eating whole grain barley can reduce blood glucose response to a meal for upto 10 hours after consumption is comparison to white or even whole grain wheat, having similar glycemic index (Alka et al, 2014). Finger millet also known, as 'ragi' is popular millet in India, consumed without dehulling. It is the principal food grain of the rural population belonging to low-income groups. At present finger millet is usually used for preparation of flour, pudding, porridge and roti (Chaturvedi and Srivastava, 2008). Ragi is considered to be ideal food for diabetic individuals due to its low sugar content and slow release of glucose/sugar in the body (Machado, 2015). The millets are a known source of dietary fiber and well known for minerals. The millets are processed by different ways viz. milling, soaking, germination, roasting, fermentation, popping, cooking, extrusion and radiation (Dagadkhair et al., 2025). Wheat (*Triticum aestivum*) is the most abundantly consumable and principal cereal crop which enhances the rolling capability of the product because of its gluten content. Therapeutic properties of whole wheat, is due to its bran along with germ which protect against diseases like-cardiovascular, diverticulum, appendicitis, constipation, obesity, etc. The present study has been conducted to develop composite flour for cheela preparation from maize in combination with other other food materials.

MATERIALS AND METHODS

The present investigation was conducted in the research laboratory of Department of Food and Nutrition, College of Community Science, Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar in the year of 2021. The grains like flaxseed, chickpea, wheat, barley and ragi selected for the study were procured from local market Pusa whereas maize (variety 'Lakshmi') was procured from farmers.

Processing of raw materials

The selected raw food grains were gone through different processing methods after cleaning viz. soaking, boiling and oven drying. Primarily all raw food grains were clean thoroughly to remove inedible parts and washed thoroughly. However, maize grains were soaked just double amount of water (1:2 w/v) for 15-20 minutes; boiled (30 minutes) and oven dried at 65°C for 10 hours. Flaxseed were roasted at 180°C for 10 to 15 minutes; cooled at room temperature and grounded. Ragi, wheat grains and chickpea were processed by soaking, overnight in water (1:2 w/v). Next day, water was drained and oven dried at 60-65°C for 7 hours excluding chickpea which took 10 hours for drying. Dried grains were grounded separately and put it into air tight container till use so that it became moisture free.

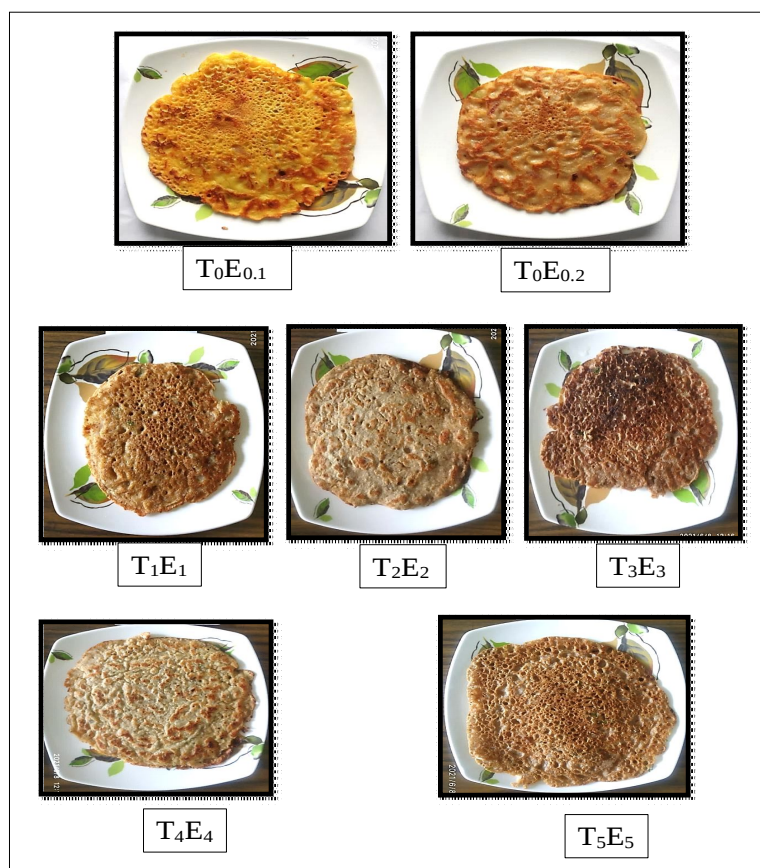


Fig 1: Cheela prepared from different treatments of flour.

Development of composite flour in different proportions

For the development of different proportions of flour, 50% of maize and 10% of flaxseed was constant because of maize had been selected as a base material and flaxseed have been decided to be added compulsorily due its nutritional and therapeutic properties. Only variations were in remaining 40% flour Table1. In developing countries the utilization of composite flour had several advantages such as: promotion of high yielding and better supply of protein for human nutrition (Jambunathan and Singh, 1980).

Formulation of *cheela*

The *cheela* was prepared by incorporating different treatments of flour in relation to wheat flour (100%). Primarily, onion and chilli was washed properly and chopped; after that batter was prepared by mixing all the ingredients including water at desired consistency; oil was applied in non-stick tawa, batter was poured and spread it to form thin layer therefore flipped both the sides until brown colour was developed and served as hot with sauce or chutney Fig 1.

Nutritional composition of *cheela*

The Energy content of *cheela* was calculated by factorial method i.e. Carbohydrate- 4 g/100 g, Protein- 4 g/100 g, Fat- 9 g/100 g respectively. The crude protein content was estimated by Micro-Kjeldahl method. However, protein percentage present in the sample was calculated by multiplying per cent nitrogen with 6.25 (Alka, 2014); whereas crude fibre, crude fat estimated by the method prescribed by AOAC (2000). The micronutrient content (Fe and Zn) was determined by using Atomic Absorption Spectrophotometer (Lindsay and Norvell, 1978). Calcium was analysed by complexo-metric titration method (Chang and Bray, 1951). Carbohydrate content was determined by subtracting the percentage of moisture, ash, crude protein, crude fat and crude fibre content from 100.

Determination of quality parameters of *cheela*

Dimension

The dimension of *cheela* prepared from varied proportion of flour was determined by means of ruler scale and compass and measured in terms of length, breadth and area (cm²). Dimension of different treatments of *cheela* was compared with control (wheat flour) which was made by different students in the Department of Food and Nutrition.

Bulk density

The bulk density of *cheela* was determined by taking 50g of sample into 100 ml of measuring cylinder. Bulk volume was measured. After that mechanical tapping was done for 10-15 times to remove air space between the sample. Bulk density was evaluated by given formula.

$$\text{Bulk density (g/ml)} = \frac{m}{v}$$

Statistical analysis

All the samples were taken in triplicate forms and represented as mean±SD. The analysis of variance (ANOVA- one way) of the data obtained was done by using completely randomized design (CRD) through OPSTAT software. The analysis of variance revealed at level of significance of P<0.05. Student t-test was used to analyze the data of quality parameters and check level of significance at 1% and 5%.

Sensory and organoleptic characteristics

Freshly prepared *cheela* of different treatments of flour was evaluated for sensory characteristics like- color, flavor, texture, taste and overall acceptability by semi-trained panel members, comprised of department, academic staff, students on 9-point hedonic rating scale.

RESULTS AND DISCUSSION

The amount and ingredients used for *cheela* preparation from different treatments of flour are given in Table 2. The amount of flour (50 g), onion (15 g) salt (2 g), oil (5 ml) and green chilli (1.5 g) were used in same amount in all treatments. Differences were found in amount of water incorporated for making dough. The more of water was taken by T₃E₃ *cheela* (160 ml) followed by T₅E₅ (150 ml), T₄E₄ (140 ml), T₂E₂ and T₁E₁ (135 ml) as compared to wheat flour *cheela* (105). Lowest amount of water was taken by chickpea flour *cheela* (90). Cooked weight of T₃E₃ *cheela* was found to be 138 g which was highest among all.

Nutritional composition of *cheela*

The nutritional composition of *cheela* prepared from different treatments of flour is represented in Table 3. However, the highest energy content was found in T₀E_{0.1} (387.76±2.13) and lowest in T₀E_{0.2} (375.06±1.74). All treatments were found significant when compared to both T₀E_{0.1} and T₀E_{0.2}. The highest protein content was found in

Table 1: Different treatments of flour.

Treatment	Maize (g)	Flaxseed (g)	Chickpea (g)	Barley (g)	Ragi (g)	Wheat (g)
T ₀	-	-	-	-	-	100
T ₁	50	10	20	20	-	-
T ₂	50	10	20	-	10	10
T ₃	50	10	20	-	20	-
T ₄	50	10	20	10	-	10
T ₅	50	10	10	10	10	10

$T_0E_{0.1}$ (19.36 ± 0.04) and lowest in T_5E_5 (6.42 ± 0.09) though in case of flour prepared from different composition T_2 contains highest protein content T_5 lowest (Yadav and Singh, 2022). Statistically, all treatments were found to be significant ($P < 0.05$) compared $T_0E_{0.1}$ and $T_0E_{0.2}$ both. Fat content was highest in $T_0E_{0.1}$ (15.28 ± 0.09) and lowest in $T_0E_{0.2}$ (6.58 ± 0.06). The significant difference ($P < 0.05$) was found among themselves when compared to $T_0E_{0.1}$ and $T_0E_{0.2}$. The highest fibre content has been found in $T_0E_{0.1}$ (25.70 ± 0.28) and lower amount in $T_0E_{0.2}$ (11.84 ± 0.96). Furthermore, all treatments showed significant difference ($P < 0.05$) compared to both $T_0E_{0.1}$ and $T_0E_{0.2}$. With regard to carbohydrate, highest amount was seen in $T_0E_{0.2}$ (67.80 ± 1.17) and lowest in $T_0E_{0.1}$ (43.21 ± 0.05). Statistically, significant difference was found between when compared to $T_0E_{0.1}$ and compared to $T_0E_{0.2}$ ($P < 0.05$).

In case of calcium content, treatment T_3E_3 (150.96 ± 0.52) seems to be higher and T_0E_0 (32.40 ± 0.43) lower. All treatments were clearly exhibited the significant difference ($P < 0.05$) among each other when compared with $T_0E_{0.1}$ and $T_0E_{0.2}$ both. The treatment T_1E_1 (7.05 ± 0.55)

showed higher iron content and $T_0E_{0.2}$ (4.28 ± 0.07) lower content. All treatment of have significant difference between each other compared to $T_0E_{0.1}$ and ($P < 0.05$) and $T_0E_{0.2}$ both Table 3. Zinc content has been found highest in T_2E_2 (3.79 ± 0.07) and lowest in $T_0E_{0.2}$ (2.90 ± 0.02). The difference among all treatments was significant between one another when compared to $T_0E_{0.1}$ except T_3E_3 at five per cent level ($P < 0.05$) among each other when compared to $T_0E_{0.2}$ respectively.

Determination of quality parameters of *cheela*

Dimension

The quality characteristics of formulated products were measured with regard to its dimension and bulk density. *Cheela* were prepared from different treatments of flour and compared with two control samples i.e. chickpea flour and wheat flour *cheela* Table 4. The area of *cheela* was measured to find out the expansion of *cheela*. The highest mean score for expansion of *cheela* was found in treatment T_3E_3 (226.56 ± 0.52) and lowest expansion (cm^2) was in diameter of $T_0E_{0.2}$ (153.54 ± 0.63).

Table 2: Amount and ingredients used for *cheela* prepared from different treatments of flour as compared to control.

Parameters	$T_0E_{0.1}$	$T_0E_{0.2}$	T_1E_1	T_2E_2	T_3E_3	T_4E_4	T_5E_5
Flour (g)	50	50	50	50	50	50	50
Salt (g)	2	2	2	2	2	2	2
Oil (ml)	5	5	5	5	5	5	5
Onion (g)	15	15	15	15	15	15	15
Green chilli (g)	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Water (ml)	90	105	135	135	160	140	150
Raw weight (g)	72	68	66	69	72	70	74
Batter Weight (g)	96	123	190	190	182	187	198
Cooked weight (g)	114	108	122	125	138	129	132
No. of <i>cheela</i>	2	2	2	2	2	2	2
Weight of 1 <i>cheela</i> (g)	54	62	57	61	56	59	64

Table 3: Nutritional composition of *cheela* prepared from different treatments of flour as compared to control.

Parameters	g/100g					mg/100g		
	Energy (Kcal) Mean $\pm$ SD	Protein Mean $\pm$ SD	Fat Mean $\pm$ SD	Fibre Mean $\pm$ SD	CHO Mean $\pm$ SD	Calcium Mean $\pm$ SD	Iron Mean $\pm$ SD	Zinc Mean $\pm$ SD
$T_0E_{0.1}$	387.76 $\pm$ 2.13	19.36 $\pm$ 0.04	15.28 $\pm$ 0.09	25.70 $\pm$ 0.28	43.21 $\pm$ 0.05	138.48 $\pm$ 1.21	4.96 $\pm$ 0.02	3.42 $\pm$ 0.08
$T_0E_{0.2}$	375.06 $\pm$ 1.74	11.16 $\pm$ 0.45	6.58 $\pm$ 0.06	11.84 $\pm$ 0.96	67.80 $\pm$ 1.17	32.40 $\pm$ 0.43	4.28 $\pm$ 0.07	2.90 $\pm$ 0.02
T_1E_1	377.84 $\pm$ 2.05	9.38 $\pm$ 0.06	10.42 $\pm$ 0.35	17.24 $\pm$ 0.80	61.86 $\pm$ 0.55	70.24 $\pm$ 0.59	7.05 $\pm$ 0.55	3.72 $\pm$ 0.05
T_2E_2	379.92 $\pm$ 0.97	11.68 $\pm$ 0.04	10.38 $\pm$ 0.06	18.12 $\pm$ 0.06	60.08 $\pm$ 0.65	105.06 $\pm$ 1.47	5.92 $\pm$ 0.03	3.79 $\pm$ 0.07
T_3E_3	385.04 $\pm$ 1.23	9.34 $\pm$ 0.06	9.36 $\pm$ 0.51	18.73 $\pm$ 0.97	63.60 $\pm$ 1.02	150.96 $\pm$ 0.52	6.06 $\pm$ 0.05	2.94 $\pm$ 0.03
T_4E_4	385.05 $\pm$ 0.51	8.18 $\pm$ 0.06	10.54 $\pm$ 0.85	17.89 $\pm$ 0.60	64.74 $\pm$ 0.93	70.78 $\pm$ 1.17	5.66 $\pm$ 0.65	3.78 $\pm$ 0.04
T_5E_5	386.62 $\pm$ 1.02	6.42 $\pm$ 0.09	9.98 $\pm$ 0.11	16.91 $\pm$ 0.07	67.78 $\pm$ 0.35	92.58 $\pm$ 0.70	4.52 $\pm$ 0.25	3.23 $\pm$ 0.03
C.D. at 5%	0.054	0.102	0.096	0.124	0.097	0.102	0.092	0.064
SE(m)	0.018	0.033	0.031	0.040	0.032	0.33	0.030	0.021
SE(d)	0.025	0.047	0.044	0.057	0.045	0.047	0.043	0.029
C.V.	0.008	0.537	0.522	0.386	0.091	0.061	0.902	0.949

Note: The atwater general factor system (Protein: 4 kcal/g, Carbohydrate: 4 kcal/g, Fat: 9 kcal/g)

C.D. at 5%

All the values are expressed in Mean $\pm$ SD,

Bulk density

The bulk density of cheela had been presented in Table 5. It was observed that the highest bulk density was found to be in treatment T_2E_2 (0.65 ± 0.03) and lowest in $T_0E_{0.2}$ (0.52 ± 0.02). The difference was shown highly significant only in T_1E_1 when compared with $T_{0.1}$ ($P < 0.01$) while, others were also significant ($P < 0.05$). However, when compared with $T_0E_{0.2}$ then highly significant ($P < 0.01$) difference was shown by T_1E_1 and remaining was significant at $P < 0.01$.

Organoleptic and acceptability quality of cheela

The organoleptic and acceptability of cheela was ascertained in different treatments of flour which has been illustrated in Table 6. It was observed that in case of appearance the highest score was found by treatment $T_0E_{0.1}$ (8.2) and lowest by $T_0E_{0.2}$ (6.2). Statistically when compared with $T_0E_{0.1}$ then significant difference ($P < 0.05$) was found in all except T_5E_5 . Moreover, the only significant difference was showed by T_4E_4 and T_5E_5 treatment when compared to $T_0E_{0.2}$. In the case of color, $T_0E_{0.1}$ treatment got highest (8.0) score and $T_0E_{0.2}$ lowest (6.3). Statistically, significant difference ($P < 0.05$) between each other as compared to $T_0E_{0.1}$ except T_5E_5 was observed when compared to $T_0E_{0.2}$. Only significant difference was found in T_4E_4 and T_5E_5 . With regard to taste, $T_0E_{0.1}$ was found to be highest score (8.9) compared to others. In case of taste highest score was found by T_5E_5 (8.5) and lowest $T_0E_{0.2}$ (6.2). Statistically, compared with $T_0E_{0.1}$ significant difference ($P < 0.05$) was observed in all treatments of excluding T_5E_5 . When compared to $T_0E_{0.2}$, all treatments showed significant difference among each other. In texture, the highest sensory score has $T_0E_{0.1}$ (8.3) and lowest $T_0E_{0.2}$ (6.1). All treatments was found to be statistically significant ($P < 0.05$) except T_5E_5 . However, non-significant difference was found only by T_1E_1 and T_3E_3 treatments as compared to $T_0E_{0.2}$. The treatment $T_0E_{0.1}$ showed highest (8.5) score in terms of flavor and $T_0E_{0.2}$ (6.8) got less. The result indicated that the significant

difference was manifested among ($P < 0.05$) all treatments compared to $T_0E_{0.1}$ excluding T_5E_5 and when compared with $T_0E_{0.2}$ then significant difference was found in T_4E_4 and T_5E_5 . Therefore, overall acceptability of $T_0E_{0.1}$ was higher (8.9) and that of $T_0E_{0.2}$ (6.1) was lower. Statistically, significant difference was seen between all treatments when compared with $T_0E_{0.1}$ excluding T_3E_3 while, all treatments were found to be statistically significant ($P < 0.05$) compared to $T_0E_{0.2}$.

Table 4: Dimension of *cheela* prepared from different treatments of flour.

Treatment	Area (cm ²)
$T_0E_{0.1}$	221.62 $\pm$ 0.21
$T_0E_{0.2}$	153.54 $\pm$ 0.63
T_1E_1	181.59 $\pm$ 0.32
T_2E_2	172.22 $\pm$ 0.47
T_3E_3	226.56 $\pm$ 0.52
T_4E_4	176.28 $\pm$ 0.32
T_5E_5	195.87 $\pm$ 0.09

All values are (Mean $\pm$ SD) of three observations

Table 5: Bulk density of *cheela* prepared from different treatments of flour.

Treatment	Bulk density (g/ml)	t' value	
$T_0E_{0.1}$	0.54 $\pm$ 0.01	$T_{0.1}$	$T_{0.2}$
$T_0E_{0.2}$	0.52 $\pm$ 0.02		
T_1E_1	0.64 $\pm$ 0.01	26**	10.26**
T_2E_2	0.65 $\pm$ 0.03	5*	7.74*
T_3E_3	0.60 $\pm$ 0.04	3.6*	5.13*
T_4E_4	0.58 $\pm$ 0.01	5.19*	4.58*
T_5E_5	0.62 $\pm$ 0.01	7*	8.87*

Values are expressed as Mean $\pm$ SD.

*Significant at 5% level of probability.

**Significant at 1% level of probability.

Table 6: Acceptability quality of *cheela* prepared from different treatments of flour.

Parameters given in (Mean $\pm$ S.D)						
Treatment	Appearance	Color	Taste	Texture	Flavor	Overall acceptability
$T_0E_{0.1}$	8.2 $\pm$ 0.63	8.0 $\pm$ 0.47	8.9 $\pm$ 0.50	8.3 $\pm$ 0.67	8.5 $\pm$ 0.84	8.9 $\pm$ 0.48
$T_0E_{0.2}$	6.2 $\pm$ 0.81	6.3 $\pm$ 0.94	6.2 $\pm$ 0.51	6.1 $\pm$ 0.91	6.8 $\pm$ 0.81	6.1 $\pm$ 0.78
T_1E_1	6.7 $\pm$ 0.70	6.9 $\pm$ 0.73	7.6 $\pm$ 0.51	6.6 $\pm$ 0.56	7.1 $\pm$ 1.19	8.2 $\pm$ 0.78
T_2E_2	6.5 $\pm$ 0.84	6.7 $\pm$ 0.94	6.9 $\pm$ 0.99	6.9 $\pm$ 1.19	7.4 $\pm$ 0.78	8.0 $\pm$ 0.78
T_3E_3	6.8 $\pm$ 0.42	7.1 $\pm$ 0.73	7.0 $\pm$ 0.47	6.4 $\pm$ 0.31	7.0 $\pm$ 0.42	8.5 $\pm$ 0.42
T_4E_4	7.3 $\pm$ 0.48	7.2 $\pm$ 0.63	7.2 $\pm$ 0.78	7.4 $\pm$ 0.51	7.6 $\pm$ 0.51	7.4 $\pm$ 0.51
T_5E_5	7.8 $\pm$ 0.91	7.9 $\pm$ 0.87	8.5 $\pm$ 0.82	7.8 $\pm$ 0.84	8.0 $\pm$ 0.81	7.9 $\pm$ 0.91
C.D.	0.633	0.682	0.617	0.699	0.723	0.627
SE(m)	0.224	0.241	0.218	0.247	0.255	0.221
SE(d)	0.316	0.340	0.308	0.349	0.341	0.313
C.V.	10.040	10.593	9.292	10.930	10.944	9.519

Values are expressed Mean $\pm$ S.D; C.D. at 5%.

CONCLUSION

In the present investigation, different treatments of flour were made and from that, cheela were prepared and subjected to analyze in term of nutritional characteristics, quality parameters. Sensory evaluation was also examined by different semi-trained panel members. The result showed that cheela made from chickpea flour $T_0E_{0.1}$ is rich nutritionally and also acceptable. Therefore, it is recommended that by replacing refined wheat flour to multigrain grain flour products in regular basis reduces the incidence of lifestyle diseases and makes people fit in future.

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Conflict of interest

All authors declared that there is no conflict of interest.

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