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FLAXSEED NUTRITIED MEAT BALLS WITH HIGH ANTIOXIDANT POTENTIAL

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ABSTRACT

*In the present era, nutraceutical foods have become a dietary inclination among consumers due to its health enhancing properties. Flaxseed is an important source of lignans which are phenolic compounds, linked to numerous health boosting effects against various life threatening ailments. To prevent different lifestyle disorders some antioxidant enriched foods must be included in our diet. To fulfill this requirement flaxseed enriched meat balls were prepared. Flaxseed bioactive moiety was obtained by using (3%) conventional solvent extraction system (T_1) and with its comparison with (T_2) supercritically extracted lignans (0.1%). Flaxseed fortified meat balls were analyzed for its physicochemical and the sensory evaluation. After properly frying the fortified balls color was investigated by CIELAB color system. The maximum L*and a* value was observed in supercritical extracted nutrified meat balls however, b*, chroma and hue angle was observed maximum in conventional solvent extracted enriched meat balls. The T_2 balls also have better texture and maximum antioxidant activity among all the treatments. In the case of sensory attributes color and over all acceptability was maximum in T_2 whist T_1 was best in texture however taste was more appreciated in control treatment.*

Keywords: Permanent income hypothesis, Absolute income hypothesis, Consumption smoothing.

1. INTRODUCTION

Globally, the emerging trends of dietary interventions have brought a radical transformation in the arena of nutrition and health. The nutritional deficiency has become a significant public health issue as one of the root cause of chronic ailments. The lifestyle related disorders are interlinked with poor dietary awareness that magnifies the free radical load, consequently weaken the antioxidative status of body (Burdock *et al.*, 2006). The improved dietary guidlines in food production and utilization have health enhancing impacts. Functional/ nutraceutical foods or supplements are natural preventive agents in human health thus, an important reason for popularity of these foods. Consumption patterns fluctuate appreciably across the world from more healthy diets such as fruits and vegetables to the ones loaded in animal fat based foodstuffs.

Importance of nutraceutical diets has been associated with productive impact on health and lowering the menace of related diseases (Shahidi, 2009).

Flaxseed (*Linum usitatissimum* L.) belongs to family *Linaceae* and is an annual seed crop of the flax plant. It is an old crop and initially cultivated to Mediterranean and West Asia (Berglund, 2002). This crop is multipurpose and is grown for seed and oil however; it also contains proteins, soluble fiber and polyunsaturated fatty acids (Pradhan *et al.*, 2010). It is gaining attention owing to its advantageous impact on cardiovascular disease, neurological & hormonal disorders. Recently flax has been considered as a potential source of bioactive food constituents that may supply health boosting properties besides providing basic nutrition (Hasler *et al.*, 2000).

The lignans are loaded in flaxseed in which SDG is major portion of lignans while matairesinol, pinoresinol, lariciresinol and isolariciresinol are also present in traces (Sicilia *et al.*, 2003). SDG has potential to be used as a natural antioxidant in foods as it prevents further oxidation reactions resulting in enhanced shelf life of foods (Eliasson *et al.*, 2003). The microflora of large intestine deglycosylate the lignans after digestion transformed into enterodiol (END) and enterolactone (ENL) that are mamalian form of lignans (Crosby, 2005).

Specialty grains such as flaxseed are utilized in preparation of ready to eat cereals for incorporation of new taste, flavor and textures in the products made (Kuntz, 1998). Composite flour comprising 15g ground flax, 0.05g oil and 80g wheat (Triticum aestivum) for its configuration chemically and its particular portion comprised macro constituents such as 6.3g protein, 5.9g fat and 29.9g carbohydrate (Soniya *et al.*, 2004). Likewise chapattis enclosing 20% of fat flax powder obtained sustainable sensory characteristics by the judges. As the amount of ground fat flax raised in ground triticum the mineral substances also elevated considerably (Hussain, 2004).

The cookies being ready from ground triticum comprising 20% flax, partly fat removed ground flax and full fat ground flax discovered satisfactory sensory characteristics (Hussain *et al.*, 2006). Concentration of the ground flaxseed 30% to 50% has been used and discovered to be suitable in muffins (Alpers and Morse, 1996). The putative health advantages of oil seeds such as flaxseed obtained attention by researchers particularly its disease modulatory function in the protection of hypercholesterolemic atherosclerosis and several other ailments (Jenkins *et al.*, 1999).

2. METHODOLOGY

2.1. Sample Preparation

The flaxseed seeds were cleaned in order to remove dust, stones and straw. The flaxseed seeds were ground (Renker, Model: GMO 1 grinder) and contained in an air tight jar and placed in lab cabinet at ambient temperature and analyzed for their quality attributes as polyphenols and antioxidant capacity.

2.2. Conventional Solvent Extraction (CSE)

The solvent extract utilized in the study (Table 1) was prepared using aqueous ethyl acetate (50% v/v) following the methods of Ho *et al.* (2007). After that the sample was placed in orbital shaker at 50c° for 50 min. Then sample was filtered and placed in rotary evaporator (Eyla, Japan) at 40^{0}C for concentration purpose.

Table-1. Treatments for solvent extraction

Treatment	Solvent	Time (min)
T_{CSE}	Ethyl acetate	50

Aqueous Ethyl acetate = (50% ethyl acetate + 50%water)

2.3. Supercritical Fluid Extraction (SFE)

The flaxseed will be subjected to supercritical fluid extraction following the method of Puengphian and Sirichote (2008). A laboratory scale supercritical fluid extraction system (FST, USA) extraction cell used was used for the determination of CO_2 loading of SDG. Carbon dioxide of 99.95% purity (Praxair, Edmonton, AB, Canada) was pressurized at 5800 psi. The extract was collected in vile and kept in freezer.

Table-2. Treatments for supercritical fluid extraction

Treatment	Solvent	Pressure (psi)
T_{SFE}	CO_2	5800

2.4. Product Development

Flax can be used as grind form or its extract may be used as an ingredient in routine food items. Extract derived from flaxseed possesses the ability to reduce the food oxidation of the products and extend their shelf life. Flaxseed extension based foods serve as a great potent tool to lifestyle related disorders. The product, flaxseed meat balls were prepared using flaxseed $extract_{CSE}$ and $extract_{SFE}$. The ingredients for meat balls preparation included chicken, ginger, garlic, spices, egg, salt, chillies, onion and oil that were purchased from local market. For each product, all the treatments had the same recipe except the variable level of flaxseed extract considering the cooking/baking losses. A control sample without flaxseed extract was also prepared for comparison purpose. According to the treatments mentioned in Table 2, 3% of flaxseed $nutraceutical_{CSE}$ was added in the recipe. Likewise, 0.1% $nutraceutical_{SFE}$ of flaxseed was added in the formulation of products. In addition, some extra amount of flaxseed extracts was used in T_1 and T_2, respectively, considering baking losses.

Table-3. Treatments used in product development

	Flaxseed meat balls
T_0	Control
T_1	Meat balls with nutraceutical extract $_{CSE}$ (3%)
T_2	Meat balls with nutraceutical extract $_{SFE}$ (0.1%)

2.5. Physicochemical Analysis of Functional/Nutraceutical Products

The prepared nutraceutical products were evaluated for color, texture and antioxidant potential during the storage period. The color and texture parameters were measured using the method of Rodriguez-Garcia *et al.* (2012). Antioxidant potential of products was determined by the estimation of total phenolic contents as described by Qiu *et al.* (2010).

2.6. Color

The products surface color, *L** (lightness), *a** (–a greenness; +a redness), and *b** (–b blueness; +b yellowness) were measured using CIE-Lab Color Meter (CIELAB SPACE, Color Tech-PCM, USA) according to method illustrated by Rodriguez-Garcia *et al.* (2012), with slight modification. The data thus obtained was used to calculate chroma (C*) and hue angle.

$$\text{Chroma } (C^*) = [(a^*)^2 + (b^*)^2]^{1/2}$$

$$\text{Hue angle } (h) = \tan^{-1} (b^*/a^*)$$

2.7. Texture

The triple beam snap (three-point break) technique of Texture Analyzer (TA-HDi, Stable Microsystems, UK) was used for measuring the texture of prepared products. A crosshead speed of 10 mm/min with a load cell of 50 kg was used. The force required to break individual product was noted and average value was calculated according to protocol described by Rodriguez-Garcia *et al.* (2012).

2.8. Antioxidant Activity

Following the method of Qiu *et al.* (2010), that was based on the reduction of phosphotungstic acid to phosphotungstic blue and as result absorbance increased due to rise in number of aromatic phenolic groups. For the purpose, 50 µL of meat ball extract was separately added to test tube containing 250 µL of Folin-Ciocalteu's reagent, 750 µL of 20% sodium carbonate solution and volume was made up to 5mL with distilled water. After two hours, absorbance was measured at 765 nm using UV/visible light Spectrophotometer (CECIL CE7200) against control that has all reaction reagents except sample extract. Total polyphenols was estimated and values were verbalized as gallic acid equivalent (mg gallic acid/100g). Each product was evaluated for antioxidant capacity determined by estimation of total phenolic contents.

2.9. Sensory Evaluation

The resultant products (cake and meat balls) prepared with different levels of flaxseed extract was assessed by a trained panel of judges at different time intervals. Flaxseed cake as well as meat balls were wrapped and placed in refrigerator. Various sensory attributes were evaluated like color, flavor, Taste, texture and overall acceptability of products according to the method of Meilgaard *et al.* (2007).

3. RESULTS

3.1. Physicochemical Analysis of Meat Balls

The physicochemical analysis of nutraceutical$_{CSE}$ and nutraceutical$_{SFE}$ meat balls was done for following traits i.e. color, texture and antioxidant potential. The results regarding these traits are discussed as under:

3.2. Color

CIELAB color system is used to perform color measurement and its attributes are L*, a* and b* where L* is the indicator of lightness–darkness, a* indicates greenish to reddish tonality, whereas b* represents bluish to yellowish tonality.

Mean square table showed that L* value for treatments T_2, T_1 and T_0 was 55.66±2.09, 53.02±1.91 and 55.66±2.09 (Table 5) and storage affected L* value substantially from 53.97±2.31 at 0 hour to 51.60±1.94 at 96 hours. Likewise, a* value (Table 6) for treatments T_2, T_1 and T_0 was 7.83±0.19, 6.30±0.22 and 4.72±0.16. Storage affected a* value and it decreased from 0 hour 5.31±0.21 to 4.59±0.13 after 96 hours of storage. Means regarding b* value (Table 7) depicted that maximum b* value was 18.64±0.94 of meat balls containing flaxseed (T_1) followed by 16.26±0.89 and 13.68±0.83 in meat balls having extract of flaxseed (T_2) and control, respectively. A significant increase was observed in b* value during storage period from 15.69±0.74 (0 hour) to 16.71±0.98 (96 hours).

Mean squares for chroma of meatballs are depicted in table 8. The value of chroma for T_0, T_1 and T_2 was 14.47±1.04, 19.69±1.15 and 18.04±1.08, respectively. (Table 9) Means for hue angle of control (T_0), nutraceutical$_{CSE}$ (T_1) and nutraceutical$_{SFE}$ (T_2) meat balls were 2.85±0.11, -2.13±0.15 and -0.58±0.13, respectively.

Table-4. Means squares for color tonality of meat balls

SOV	Df	L* value	a* value	b* value	Chroma	Hue angle
Treatment (A)	2	128.475**	36.1819^{NS}	92.5496**	106.766*	9.3438*
Days (B)	4	7.912*	1.5543^{NS}	1.4244^{NS}	0.502^{NS}	26.1938^{NS}
A x B	8	0.715^{NS}	0.2040^{NS}	0.0268^{NS}	0.015^{NS}	7.6420^{NS}
Error	30	54.838	0.0622	5.2335	6.031	0.1211

^{NS} = Non-significant

* = Significant

** = Highly significant

Table-5. Effect of treatments and storage on L* value of meatballs

Storage intervals (days)	Treatments			Means
	T_0	T_1	T_2	
0	50.27±2.37	54.47±2.19	57.17±2.39	53.97±2.31e
24	50.41±2.12	53.65±2.14	56.32±2.13	53.46±2.18d
48	50.37±2.08	52.76±1.95	55.44±2.03	52.85±2.05c
72	49.85±2.02	52.25±1.92	54.73±1.98	52.27±1.99b
96	48.18±1.93	51.98±1.87	54.64±1.89	51.60±1.94a
Means	49.81±2.05a	53.02±1.91b	55.66±2.09c	

T_0 = Control (without active ingredient)

T_1 = meat balls containing 3%flaxseed extract

T_2 = meat balls containing 0.1% flaxseedextract

Table-6. Effect of treatments and storage on a* value of meat balls

Storage intervals (days)	Treatments			Means
	T_0	T_1	T_2	
0	4.95±0.17	6.68±0.24	8.54±0.18	6.72±0.21e
24	4.89±0.13	6.59±0.21	7.87±0.16	6.45±0.19d
48	4.84±0.14	6.51±0.18	7.75±0.14	6.37±0.17c
72	4.79±0.09	6.49±0.15	7.54±0.17	6.27±0.16b
96	4.13±0.15	5.25±0.13	7.43±0.12	5.60±0.13a
Means	4.72±0.16a	6.30±0.22b	7.83±0.19c	

Table-7. Effect of treatments and storage on b* value of meat balls

Storage intervals (days)	Treatments			Means
	T_0	T_1	T_2	
0	13.28±0.85	18.10±1.06	15.68±0.76	15.69±0.74ba
24	13.45±0.83	18.43±0.92	15.92±0.85	15.93±0.92b
48	13.70±0.78	18.67±1.03	16.37±0.73	16.25±0.83c
72	13.57±0.74	18.75±0.84	16.56±0.89	16.39±0.95d
96	14.11±0.76	19.27±1.09	16.75±0.92	16.71±0.98e
Means	13.68±0.83a	18.64±0.94c	16.26±0.89b	

T_0 = Control (without active ingredient)

T_1 = meat balls containing 3% flaxseed

T_2 = meat balls containing flaxseed 0.1% extract

Table-8. Effect of treatments and storage on chroma of meat balls

Storage intervals (days)	Treatments			Means
	T_0	T_1	T_2	
0	14.17±0.87	19.29±1.07	17.85±0.97	17.10±0.79a
24	14.31±1.02	19.57±1.09	17.75±1.02	17.21±0.73b
48	14.52±0.83	19.77±1.15	18.11±1.07	17.47±0.69c
72	14.65±0.88	19.84±1.21	18.19±1.13	17.56±0.81d
96	14.70±0.91	19.97±1.32	18.32±1.09	17.66±0.77e
Means	14.47±1.04a	19.69±1.15c	18.04±1.08b	

Table-9. Effect of treatments and storage on hue angle of meat balls

Storage intervals (days)	Treatments			Means
	T_0	T_1	T_2	
0	-2.02±0.18	-2.16±0.16	-0.27±0.15	-1.48±0.17a
24	-2.42±0.14	-2.78±0.13	-0.48±0.09	-1.89±0.16ab
48	-3.11±0.12	-3.56±0.09	-0.60±0.17	-2.42±0.09ab
72	-3.91±0.09	-3.87±0.12	-0.72±0.12	-2.83±0.12b
96	3.54±0.05	1.71±0.08	-0.81±0.07	1.48±0.14bc
Means	2.85±0.11b	-2.13±0.15a	-0.58±0.13ab	

T_0 = Control (without active ingredient)
T_1 = meat balls containing flaxseed
T_2 = meat balls containing flaxseed extract

3.3. Texture

The texture of the meat balls were analyzed through texture analyzer by measuring the force applied on the surface of meat balls. Mean squares regarding texture of meat balls showed significant difference due to treatments and storage period also depicted significant difference while interaction effect was non-significant (Table 10). Means for texture showed maximum value 9.69±0.08 kg force for nutraceutical$_{SFE}$ (T_2) followed by 9.56±0.05 and 9.67±0.06 in control (T_1) and nutraceutical$_{CSE}$ meat balls (T_0), respectively. Texture of meat balls were affected with the passage of time and it increased from 9.51±0.03 at 0 hour to 9.69±0.08 kg force at 96 hours (Table 8). (Huda *et al.*, 2009) studied that meat balls using potato flour shows the highest values of hardness, cohessivness and elasticity.

Table-10. Means squares for texture of meat balls

SOV	df	Texture
Treatment (A)	2	0.49218*
Days (B)	4	0.02245*
A x B	8	0.00321^{NS}
Error	30	0.08144

^{NS} = Non-significant

* = Significant

** = Highly significant

Table-11. Effect of treatments and storage on texture (kg force) of meat balls

Storage intervals (days)	Treatments			Means
	T_0	T_1	T_2	
0	9.20±0.06	9.47±0.05	9.51±0.04	9.51±0.03a
24	9.23±0.05	9.49±0.06	9.54±0.05	9.54±0.04b
48	9.25±0.09	9.52±0.07	9.62±0.03	9.62±0.05c
72	9.29±0.07	9.55±0.05	9.65±0.07	9.65±0.06d
96	9.31±0.04	9.58±0.04	9.69±0.08	9.69±0.08e
Means	9.30±0.05a	9.56±0.08b	9.67±0.06c	

T_0 = Control (without active ingredient)

T_1 = meat balls containing 3% flaxseed extract

T_2 = meat balls containing 0.1% flaxseed extract

3.4. Antioxidant Potential of Meat Balls

The antioxidant potential of meat balls were evaluated by determining the total phenolic contents (TPC). Mean squares for TPC of meat balls depicted significant differences due to treatment and storage period. Means regarding TPC illustrated that maximum value of TPC 79.13±8.92 mg GAE/100g was observed in meat balls containing nutraceutical$_{SFE}$ of flaxseed (T_2) while the value of TPC was 70.02±8.76 and 50.64±8.38 mg GAE/100g for meat balls having flaxseed (T_1) and control (T_0), respectively. Storage affected the TPC with passage of time and its value decreased from 9.87±9.18 to 76.77±8.12 mg GAE/100g during the study period of 96 hours (Table 13).

There are decent amount of total phenolic contents in meat balls and it further increased due to addition of flaxseed extract in nutraceutical$_{CSE}$ and nutraceutical$_{SFE}$ meat balls, respectively.

Table-12. Means squares for total phenolics of meat balls

SOV	Df	Total phenolics
Treatment (A)	2	3244.86*
Days (B)	4	262.87*
A x B	8	1.17^{NS}
Error	30	17.87

^{NS} = Non-significant

* = Significant

** = Highly significant

Table-13. Effect of treatments and storage on total phenolics (mg GAE/100g) of meat balls

Storage intervals (days)	Treatments			Means
	T_0	T_1	T_2	
0	62.07±9.52	82.78±9.21	90.87±8.94	90.87±9.18e
24	58.49±9.16	79.81±9.08	87.01±9.32	87.01±9.02d
48	55.38±8.76	75.38±8.87	84.25±8.98	84.25±8.73c
72	52.01±8.45	71.49±8.73	81.49±8.73	81.49±8.37b
96	49.28±8.23	68.56±8.48	76.77±8.66	76.77±8.12a
Means	50.56±8.38a	70.02±8.76b	79.13±8.92c	

T_0 = Control (without active ingredient)

T_1 = meat balls containing 3%flaxseed extract

T_2 = meat balls containing 0.1%flaxseed extract

3.5. Sensory Evaluation of Meat Balls

Meat balls were ranked for sensory evaluation using 9 point hedonic scale for their color, flavor, taste, crispiness and overall acceptability. Table 14 has described mean squares for the effect of treatment, storage and their interaction on sensory attributes of meat balls. It was revealed that treatments had significant effect on texture, taste and overall acceptability while non-significant effect on color and flavor of meat balls. Similarly, same trend was seen in case of storage except flavor that had significant effect. In all meat balls prepared with flaxseed extract, storage and treatment interaction had non-significant effect on all sensory traits.

Means for effect of treatments (Table 15) explicated non-significant effect on color of meat balls; maximum score 7.28±0.32 was assigned to T_2 (0.1% nutraceutical$_{SFE}$ extract) followed by T_0 (control) 7.21±0.29 while minimum 7.14±0.27 to T_1 (7%nutraceutical$_{CSE}$). Color scores for meat balls reduced non-significantly as of storage from 7.39±0.28 to 7.05±0.19.

Table-14. Mean squares for sensory evaluation of meat balls

SOV	df	Color	Texture	Taste	Overall acceptability
Treatment (A)	2	0.08216^{NS}	0.7036*	0.5308*	0.43818*
Days (B)	4	0.16252^{NS}	0.7363*	0.6530*	0.37930*
A x B	8	0.0046^{NS}	0.007^{NS}	0.008^{NS}	0.0118^{NS}
Error	30	0.07475	0.224	0.099	0.11939

^{NS} = Non-significant

* = Significant

** = Highly significant

Table-15. Effect of treatments and storage on color of meat balls

Storage intervals (days)	Treatments			Means
	T_0	T_1	T_2	
0	7.38±0.35	7.36±0.32	7.44±0.30	7.39±0.28e
24	7.28±0.32	7.20±0.28	7.36±0.35	7.28±0.24d
48	7.18±0.24	7.16±0.31	7.26±0.26	7.20±0.22c
72	7.12±0.28	7.06±0.25	7.20±0.24	7.13±0.21b
96	7.08±0.22	6.90±0.24	7.16±0.29	7.05±0.19a
Means	7.21±0.29b	7.14±0.27a	7.28±0.32c	

T_0 = Control (without active ingredient)

T_1 = meat balls containing flaxseed

T_2 = meat balls containing flaxseed extract

Table-16. Effect of treatments and storage on texture of meat balls

Storage intervals (hours)	Treatments			Means
	T_0	T_1	T_2	
0	7.10±0.28	7.58±0.29	7.16±0.32	7.28±0.28e
24	6.96±0.22	7.34±0.24	7.02±0.24	7.11±0.26d
48	6.88±0.25	7.14±0.35	6.94±0.29	6.99±0.21c
72	6.58±0.24	7.02±0.22	6.64±0.26	6.75±0.23b
96	6.40±0.29	6.84±0.36	6.44±0.31	6.56±0.17a
Means	6.78±0.24a	7.18±0.29c	6.84±0.26b	

T_0 = Control (without active ingredient)

T_1 = meat balls containing 3% flaxseed

T_2 = meat balls containing flaxseed 0.1% extract

Table-17. Effect of treatments and storage on taste of meat balls

Storage intervals (days)	Treatments			Means
	T_0	T_1	T_2	
0	7.52±0.25	7.02±0.32	7.46±0.24	7.33±0.31e
24	7.24±0.32	6.90±0.31	7.22±0.30	7.12±0.26d
48	7.06±0.26	6.82±0.24	7.02±0.24	6.97±0.24c
72	6.92±0.34	6.58±0.33	6.88±0.32	6.79±0.22b
48	6.76±0.29	6.46±0.22	6.72±0.26	6.65±0.17a
Means	7.10±0.34c	6.76±0.31a	7.06±0.32b	

Table-18. Effect of treatments and storage on overall acceptability of meat balls

Storage intervals (days)	Treatments			Means
	T_0	T_1	T_2	
0	7.48±0.28	7.39±0.34	7.54±0.29	7.47±0.32e
24	7.44±0.30	7.04±0.28	7.46±0.31	7.31±0.29d
48	7.24±0.24	6.98±0.24	7.28±0.26	7.17±0.27c
72	7.12±0.26	6.82±0.32	7.16±0.28	7.03±0.25b
96	7.06±0.31	6.74±0.23	7.10±0.32	6.97±0.24a
Means	7.27±0.30b	6.99±0.29a	7.31±0.31c	

T_0 = Control (without active ingredient)

T_1 = meat balls containing 3% flaxseed extract

T_2 = meat balls containing 0.1%flaxseed extract

Means for texture of meat balls (Table 17) showed that maximum score of texture 7.18±0.29 was noted for T_1 while 6.84±0.26 for T_2 and minimum score i.e. 6.78±0.24 was recorded for $T_{0.}$ Storage intervals demonstrated significant reduction from 7.28±0.28 to 6.56±0.17. Means demonstrated in (Table 17) explained significant differences in taste of meat balls due to treatment as well as storage. Maximum score for taste was assigned to T_0 (7.10±0.34) while minimum to T_1 (6.76±0.31) as nutraceutical of treatment. Likewise, storage also led to significant decrease in taste score from 7.33±0.31 to 6.64±0.17. In view of the overall acceptability, T_2 was considered best with allocated score (7.33±0.31), whereas T_1 at the lower level with score (7.02±0.29). Overall acceptability progressively decreased from 7.47±0.32 to 6.65±0.24 during 96 hours storage of meat balls (Table 18).

Serdaroglu *et al.* (2005) studied that factors affect the textural properties of meat balls in degree of myofibrillar proteins. Starch will play a decisive role on hardness of meat balls. Yilmaz and Daglioglu (2003) also proved the difference in color properties of different meat balls may be due to different brands and other non-meat ingredietns.

4. CONCLUSION

A remarkable aspect of present study project was to design a novel nutraceutical food to fight against lifestyle related disorders. For this purpose, two nutraceutical products were prepared from flax. Flaxseed cake and meat balls were prepared with the idea of developing new supplemented products. Three products were evaluated under each category; control as T_0 (without flax), nutraceutical$_{CSE}$ as T_1 (with 3% flax extract) and nutraceutical$_{SFE}$ as T_2 (with 0.1% flax extract). Prepared products were stored and analyzed for physicochemical properties (color and texture), antioxidant capacity and sensory aspects. Mean squares pertaining to color tonality of cakes measured through CIELAB colorimeter showed significant effect of treatment on L*, a*, b*, chroma and hue angle whilst storage interval showed non-significant effect except for a* value.

Total phenolic contents and texture analysis of cake and meatballs were observed and sensory attributes like cake cell, texture, grain, color and flavor of cake and color taste, texture and overall acceptability of meatballs were evaluated by trained panelists. Means squares for sensory evaluation showed variable effects due to treatments, storage and their interaction. Best scores for sensory assessment in cakes were recorded for T2. Likewise, In case of color of meat balls, Highest L* value was for control 47.59±2.05 and the lowest for T1 (3% flaxseed extract) 39.95±1.91. While a* and b* values were the lowest for T0 (4.78±0.16) and T0 (22.22±0.83), respectively. The value for chroma was the highest (29.81±1.15) for T1 (meat balls containing 3% flaxseed extract) while the lowest (23.54±1.04) for T0 (control). The value of hue angle was the highest for T1 (3.41±0.15)

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