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Organoleptic, physical, nutritional characteristics and storage stability of value added Kodo masala khakhra

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Abstract

Kodo millet is one of the underutilized and nutritious minor millet. Not much work has been done in the utilization of this millet hence the present study was taken up with an objective to develop value added product masala khakhra, analyze its nutritional composition and study shelf life. Masala khakhra was prepared by incorporating Kodo flour replacing wheat flour at different proportions. Nutritional composition was analyzed by using standard protocols. Results revealed that, developed product was acceptable up to 60% Kodo flour incorporation. Developed product had 12 g protein, 3 g fat, 57 g carbohydrate, 13 g crude Fibre and 295 K. calories of energy. Free fatty acid, peroxide value and microbial load were within safe limits up to 60 days. Thus, acceptable shelf stable value added products can be developed from Kodo millet.

Keywords: KMK, Kodo, Khakhra, flour, FFA, Peroxide, moisture, Antioxidants

Introduction

Increasing population, climatic changes and scarcity of natural resources affecting adversely on socioeconomic conditions throughout the world. Millets are draught resistant crops and can save natural resources. Most importantly millets are nutritionally superior compared to other cereals. Several studies reported that, millet consumption helps to reduce the risk of CVD, diabetes, digestive problems, cancer risks, respiratory problems, muscular problems, neural problems, metabolic disorders and Parkinson's disease (Manach *et al.*, 2005; Scalbert *et al.*, 2005; Chandrasekara and Shahidi, 2012) ^[13, 20, 5].

Kodo millet (*paspalum scrobiculatum*) is a minor millet belongs to Poaceae family. Kodo millet is divided in damp habitats across the tropics and subtropics of the world. It is mainly grown in Madhya Pradesh, Maharashtra, and Uttar Pradesh and various other parts of India (Neelam Y. *et al.*, 2013) ^[14]. This cereal is also known as Varagu in Tamil, kodo in English and haraka in kannada (Mall and Tripathi, 2016) ^[12]. Kodo millet is a nutritious grain as compared to wheat and rice. The protein, mineral content, and fiber content are higher than rice (Ohariya, 2013) ^[15]. It is well known that fiber helps in maintaining the normal cholesterol and glucose levels and helps avoid constipation. Kodo millet is the main source of protein and minerals in the daily diets of tribal and weaker section living in remote rural areas (Ahmad M.S., and Yadava H.S, 1996) ^[2]. Because of this reason kodo millet is usually called as a poor man's food. Kodo millet contains good amount of lecithin and helps in strengthening the nervous system. Kodo millet is also rich in vitamins especially niacin, folic acid and vitamin E. It has minerals such as calcium, iron, magnesium, potassium, zinc, manganese and phosphorus, makes millets an important nutritional bio- source (Dayakar B *et al.*, 2018) ^[6]. Several literatures have reported that kodo millet can be used to develop various traditional as well as novel food products like, dosa, idli, cookies, laddoo, biscuits, pongal, bread etc., (Kalpana *et al.*, 2013; Senthamarai *et al.*, 2013; Padma and Rajendren, 2013) ^[9, 21, 16]. In the present study an attempt was made to develop value added masala Khakhra by kodo millet, study its acceptability and shelf life.

Materials and Methods

Selection of raw materials: Raw materials for preparation of masala khakhra were purchased from the local market of the Bangalore. Kodo millet was purchased from Organic farmer's association federation ltd. Davangere and Chitradurga district.

Formulation and Standardization of Value Added Masala Khakhra

Masala Khakhra was standardized by incorporation of Kodo millet flour with wheat flour at different levels i.e. control with 100% wheat flour and other variations by replacing wheat

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flour with Kodo millet flour at 10%, 20%, 30%, 40%, 50%, 60%, and 70% (Table 1). The procedure for preparation of

masala khakhra is mentioned in Fig. 1

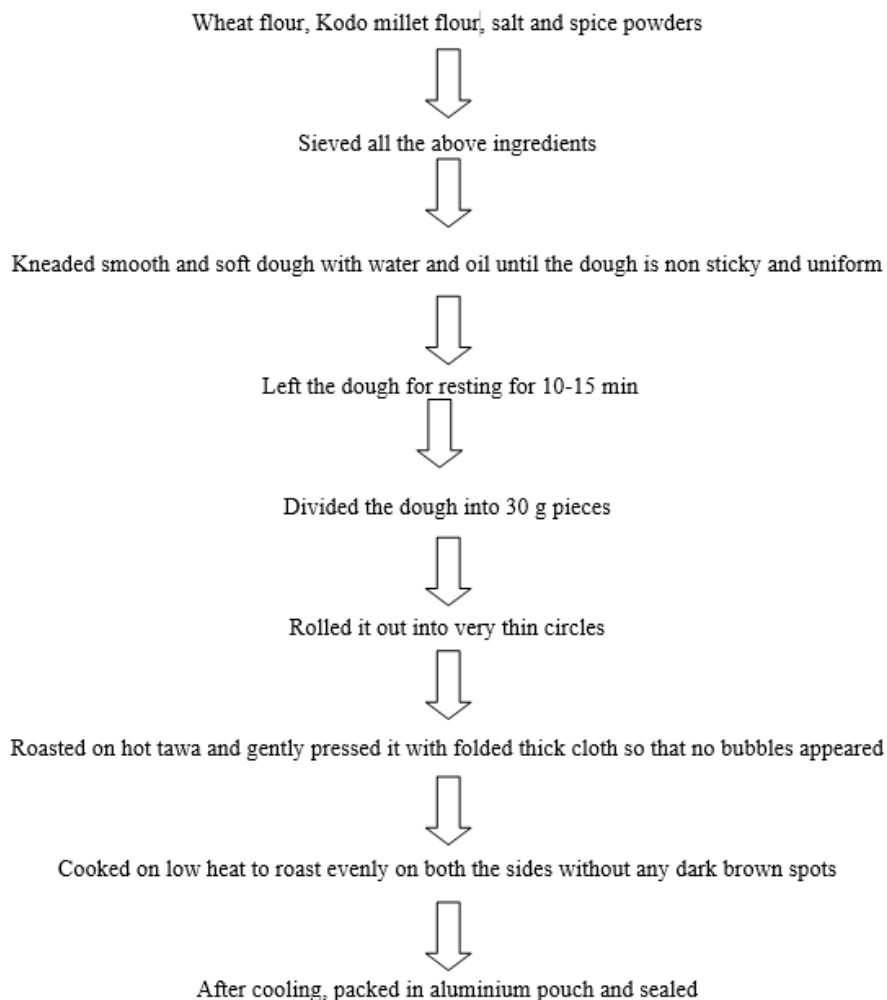


Fig 1: Flow Chart for the Preparation of Kodo Masala Khakhra

Table 1: Formulation and Standardization of Value Added Kodo Millet Based Masala Khakhra

Treatments	Whole wheat flour (%)	Kodo millet flour (%)	Salt (g)	Oil (ml)	Cumin seeds(g)	Chilli powder (g)	Turmeric (g)	Blackpepper (g)	Ajwain (g)	Mango powder(g)	Asafoetida (g)
CMK	100	00	4	3.0	1	2	0.3	0.3	0.2	2	0.3
KMK1	90	10	4	3.0	1	2	0.3	0.3	0.2	2	0.3
KMK2	80	20	4	3.0	1	2	0.3	0.3	0.2	2	0.3
KMK3	70	30	4	3.0	1	2	0.3	0.3	0.2	2	0.3
KMK4	60	40	4	3.0	1	2	0.3	0.3	0.2	2	0.3
KMK5	50	50	4	3.0	1	2	0.3	0.3	0.2	2	0.3
KMK6	40	60	4	3.0	1	2	0.3	0.3	0.2	2	0.3
KMK7	30	70	4	3.0	1	2	0.3	0.3	0.2	2	0.3

CMK: Wheat Khakhra (Control), KMK: Kodo Masala Khakhra, KMK1:10% kodo millet incorporation,, KMK2:20% kodo millet incorporation,, KMK3: 30% kodo millet incorporation,, KMK4: 40% kodo millet incorporation,, KMK5: 50% kodo millet incorporation,, KMK6: 60% kodo millet incorporation,, KMK7: 70% kodo millet incorporation

Sensory evaluation: Sensory evaluation of the control masala khakhra and all the variations was done with the help of nine points hedonic scale by a panel of twenty one semi trained panellists.

Nutrient composition: Nutrient composition of highly accepted kodo masala khakhra per 100g was analyzed by following the AOAC (2000) [3] official protocols. All samples were analyzed in triplicates. Moisture content was determined from sample weight loss after drying at 110° C for 4 hour. Protein content was determined by Kjeldahl method. The Soxhlet method was used for total fat determination. Crude

fiber was estimated by treatment of sample first with acid and subsequently with alkali.

The loss in weight was taken as the crude fibre content. Carbohydrate and energy were analyzed by difference method (Livesey, 1995) [11].

Ash was analyzed by using muffle furnace. Calcium content of the sample was estimated by preparing mineral solution and titrating it against 0.01 N EDTA in the presence of alkaline condition (Heau *et al.*, 1965) [8]. The iron content of the sample was estimated by using atomic absorption spectrophotometer and the results were expressed in mg per 100 g of the sample (AOAC, 1980) [11].

Estimation of Total Antioxidant activity (Kang and Saltveit, 2002) [10]:

The disappearance of the DPPH (1,1-Diphenyl-2-picrylhydrazyl) radical absorption at 517 nm by the action of antioxidants is measured spectrophotometrically in a methanolic solution until the absorbance remains constant.

Estimation of Total Polyphenols (Sadasivam and Manickam, 1991) [19].

Blue colour developed by Polyphenols Folin-ciocalteu (FCR) reagent in alkaline condition was measured at 650 nm.

Estimation of tannins (Ranganna, 2005) [18].

Tannins were estimated colorimetrically based on the measurement of blue color formed by the reduction of phosphotungstomoybdic acid in alkali solution.

Estimation of Phytic acid (E.L. Wheeler and R.E. Ferrel, 1971) [7].

The phytate was extracted with trichloroacetic acid and

precipitated as ferric salt. The iron content of the precipitate was determined colorimetrically and the phytate phosphorus content calculated from value assuming a constant 4 Fe: 6 molecular ratios in the precipitate. Phytates were estimated as phytic and phytate phosphorous were obtained.

Storage quality evaluation: The Control and kodo masala khakhras were packed in aluminium silver pouch and plastic pouches, heat sealed and stored in cardboard boxes at ambient temperature for a period of 60 days. The storage quality of control masala khakhra and kodo masala khakhra were evaluated for moisture content, free fatty acid (FFA), peroxide value (PV), microbial load (pour plate method) and sensory quality at the interval of 30 days for a period of 60 days.

Statistical analysis

All the experiments were performed in triplicates and completely randomized design was carried out for the experimental values in order to know the significant difference (at 5% significant level).

Table 2: Physical properties of value added masala Khakhra

Variations	Water uptake (ml) for dough making	Weight of the dough (gm)	Total Weight of khakhra after roasting (gm)	Weight of each khakhra (gm)	Diameter (cm)	Thickness (mm)
CMK	75.33±0.58	182.67±0.58	113.67±0.58	19.08±0.12	19.42±0.01	1.87±0.06
KMK1	76.00±1.00	184.33±0.58	114.33±0.58	19.10±0.17	18.31±0.01	1.93±0.15
KMK2	77.33±1.15	186.33±0.58	115.33±0.58	19.14±0.02	18.27±0.06	2.00±0.17
KMK3	80.33±0.58	188.67±0.58	115.33±0.58	19.14±0.02	18.12±0.01	2.17±0.06
KMK4	82.67±0.58	190.67±0.58	116.33±0.58	19.29±0.07	18.11±0.01	2.27±0.06
KMK5	85.67±0.58	192.67±0.58	118.33±0.58	19.84±0.04	17.12±0.02	2.37±0.06
KMK6	87.67±0.58	194.67±0.58	120.00±0.00	19.91±0.09	16.07±0.06	2.50±0.00
KMK7	89.67±0.58	196.00±1.00	120.33±0.58	19.96±0.06	15.13±0.04	2.53±0.12
F value	0.4249	0.3727	0.3118	0.0506	0.0190	0.0577
SEm±	**	**	**	**	**	**
CD(5%)	1.2739	1.1173	0.9348	0.1516	0.0570	0.1731

**significant at $p < 0.01$

Physical characteristics *viz.*, water uptake, weight of the Khakhra, diameter and thickness were studied and presented in Table 2. As the level of incorporation of Kodo flour increased, water uptake capacity of dough (76 ml to 89.67ml), weight of the dough (184 gm to 196 gm) and weight of the Khakhra (114 to 120) increased. Water absorption of Kodo millet was higher than wheat flour as it is rich in dietary fibre. The decrease in diameter (18 cm to 15 cm) and increase in

thickness (1.93 to 2.53 mm) of Kodo khakhra was observed with increase in level of Kodo flour incorporation. Wheat protein gluten is elastic in nature and as a result, Khakhra with wheat flour can be rolled into thin circles. But Kodo is gluten free and as the Kodo level increases in dough, elasticity of the dough decreases. So, diameter decreases and thickness increases. Similar results were reported by Amudha (2006) and Solanke *et al* (2018) [22] also.

Table 3: Mean Organoleptic Scores of Value Added Masala Khakhra

Sample	Appearance	Colour	Texture	Aroma	Taste	Overall acceptability
CMK	8.67±0.49	8.54±0.66	8.58±0.67	8.25±0.75	8.38±0.64	8.50±0.52
KMK1	8.50±0.67	8.46±0.66	8.50±0.52	8.25±0.62	8.33±0.89	8.38±0.48
KMK2	8.42±0.79	8.29±0.62	8.17±0.94	8.08±0.79	8.07±0.88	8.07±0.88
KMK3	8.17±0.83	8.13±0.80	8.17±0.93	8.00±0.95	8.08±1.08	8.12±0.85
KMK4	8.00±0.85	8.04±0.86	8.08±0.90	7.83±1.03	7.73±1.19	7.85±1.06
KMK5	8.17±0.72	8.21±0.58	8.04±0.45	7.75±0.87	7.71±0.92	7.83±0.72
KMK6	7.58±1.00	7.46±0.94	7.50±0.67	7.17±1.19	7.25±1.06	7.04±1.14
KMK7	7.25±0.97	7.29±1.01	6.83±0.83	7.42±1.16	7.17±1.11	6.92±1.00
F-value	0.2402	0.2254	0.2199	0.2716	0.2850	0.2487
SEm±	**	**	**	**	**	**
CD (5%)	0.6750	0.6336	0.6180	0.7634	0.8010	0.6990

*significant at $p < 0.05$ **significant at $p < 0.01$

Table 3 depicts the mean organoleptic scores of value added masala khakhra for the characteristics of appearance, colour, texture, aroma, taste and overall acceptability. These variations of Khakhra were prepared by incorporating Kodo millet flour at different levels. i.e. 10, 20, 30, 40, 50, 60 and 70

percent. The scores for appearance ranged from 7.25 to 8.67, for colour 7.29 to 8.54, for texture 6.83 to 8.58, for aroma 7.42 to 8.25, for taste 7.17 to 8.38 and for overall acceptability 6.92 to 8.50. The control had the highest score for all the sensory characteristics. Among Kodo khakhras,

KMK1 (10% Kodo flour incorporated) was found to be best accepted and KMK7 (70% Kodo flour incorporated) had lesser scores for all the sensory characteristics. The difference in sensory scores was also found to be statistically significant at 5% level. People are used to the appearance and taste of Khakhra prepared with only wheat flour, the original recipe. Hence, as the level of incorporation of Kodo millet increased, the sensory scores for Khakhra decreased in the present study. However, till 60% incorporation of Kodo flour Kodo khakhra can be very well considered as acceptable as it

scored between like moderately to like very much.

Solanke *et al.* (2018) [22] have reported that Khakhra with 10% garden cress seed flour and buck wheat flour was accepted with 8.44 score. Vernekar *et al.* (2018) [25] have reported that Khakhra with 5% incorporation of betel leaves powder was better accepted than higher concentrations. Surekha and Ravikumar (2014) [24] prepared barnyard Khakhra incorporating wheat flour at 20,30 and 40% level and observed that 40% level incorporation scored the best.

Table 4: Nutritional Composition of Control and Kodo Masala Khakhra(KMK6)/100g

Variations	Moisture (g)	Fat (g)	Protein (g)	Carbohydrate (g)	Crude Fibre (g)	Ash (g)	Energy (K.cal.)	Calcium (mg)	Iron (mg)
CMK	4.15±0.06	3.55±0.03	12.3±0.025	56.97±1.11	10.33±1.53	3.81±0.06	300.33±4.04	36.83±3.87	4.88±0.03
KMK6	3.52±0.02	3.07±0.03	12.33±0.03	56.80±1.61	13.33±0.05	3.45±0.23	295.33±6.03	43.89±2.49	5.00±0.01
SEm±	0.0233	0.0156	0.0149	0.7958	0.6239	0.0961	2.9627	2.2998	0.0146
F value	**	**	NS	NS	*	NS	NS	NS	*
CD (5%)	0.0916	0.0614	0.0585	3.1245	2.4499	0.3773	11.6331	13.9938	0.0887

*significant at $p < 0.05$ **significant at $p < 0.01$ NS-Non Significant

Table 4 represents the nutritional composition of 60% Kodo millet incorporated masala Khakhra (KMK6) in comparison with control masala khakhra. Moisture and fat contents were significantly higher in control masala khakhra compared to kodo masala khakhra (4.15 and 3.55 g respectively). Crude fibre and Iron contents were significantly high in kodo masala

khakhra compared to control masala khakhra (13.33 g and 5 mg respectively). This is because kodo is rich in fibre. The difference between control and kodo masala khakhra for protein, carbohydrate, ash and calcium contents was statistically non-significant.

Table 5: Anti-Nutritional and Antioxidant Composition of Control and Kodo Masala Khakhra

Variations	Total antioxidants (%)	Polyphenols (mg/100g)	Tannins (%)	Phytic acid (g/100g)
CMK	42.38±0.03	21.57±1.26	2.58±0.08	0.53±0.07
KMK6	51.35±0.03	21.20±1.12	4.44±0.02	0.66±0.05
F-value	**	NS	**	*
SEm±	0.0170	0.6896	0.0318	0.0328
CD (5%)	0.0667	2.7078	0.1249	0.1289

*significant at $p < 0.05$ **significant at $p < 0.01$ NS-Non Significant

Table 5 denotes the anti-nutritional and antioxidant composition of control and kodo masala khakhra (Standard curves are denoted in Fig. 2 to 5). Total antioxidants in kodo masala khakhra was significantly more compared to control masala khakhra (51.35 and 42.38 respectively). Tannins and Phytic acid contents were also significantly more in kodo masala khakhra (4.44 and 0.66 respectively). Polyphenols did not show any significance difference. Balasubramanian., 2013 [4] stated that anti nutrients present in kodo millet hinder the solubility and bioavailability of micro nutrients. However, soaking, germination, decortication, fermentation processes are able to reduce the tannins and phytate contents in kodo millet.

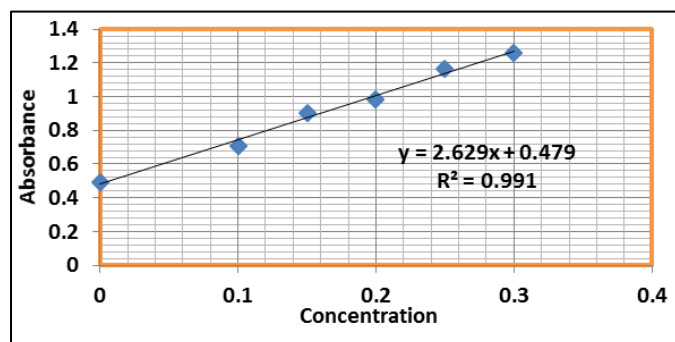


Fig 2: Standard graph for estimation of Total antioxidants

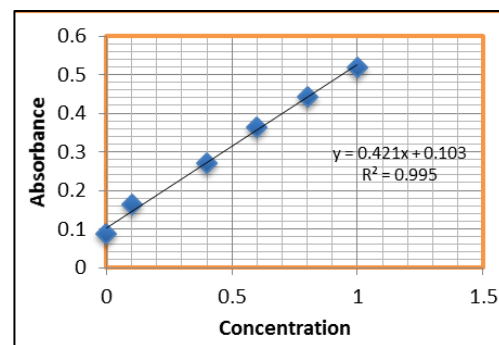


Fig 3: Standard graph for estimation of Polyphenols

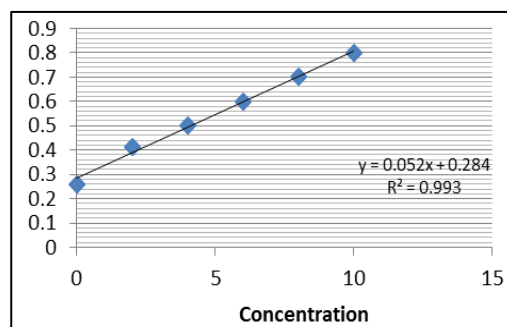


Fig 4: Standard graph for estimation of Phytic acid

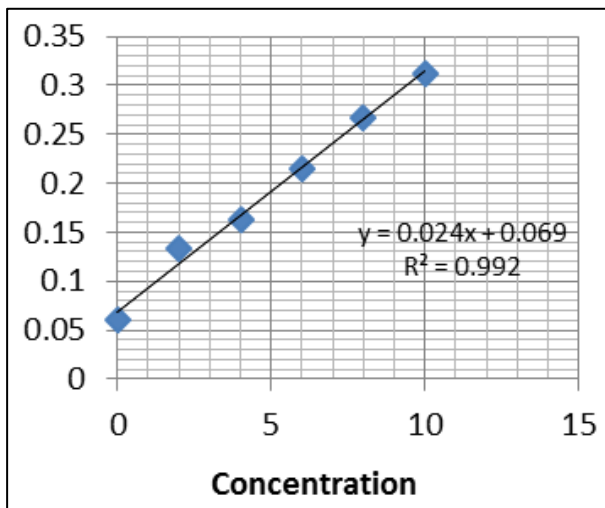


Fig 5: Standard graph for estimation of Tannins

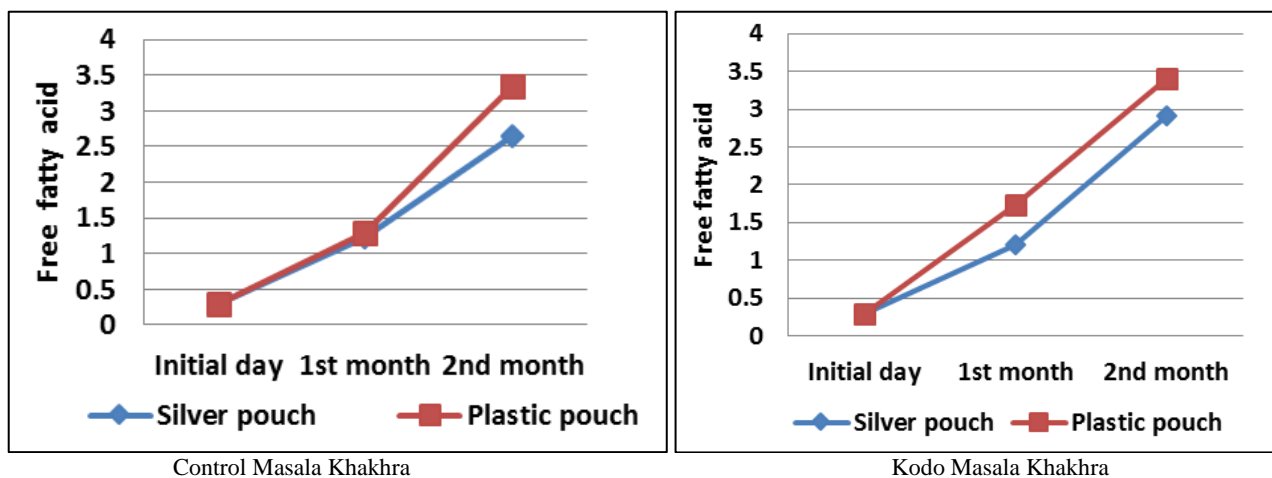


Fig 6: Free Fatty Acid Values (%) of Masala Khakhra on Storage

Fig. 6 shows the free fatty acid values of the developed products from initial to 60th day of storage. The increase in free fatty acid value (FFA) of control khakhra when stored in silver pouch was from 0.30 to 2.64% and in plastic pouch from 0.30 to 3.34%. In Kodo masala khakhra, it was observed that FFA increased from 0.30 to 2.91% in silver pouch and 0.30 to 3.41% in plastic pouch. Between silver and plastic

storage pouches, there was significant difference in control masala khakhra on 60th day i.e., free fatty acid was significantly high in plastic pouch compared to silver pouch (3.34 and 2.64 respectively). No significant difference in free fatty acid value was observed between both the storage materials in kodo masala khakhra.

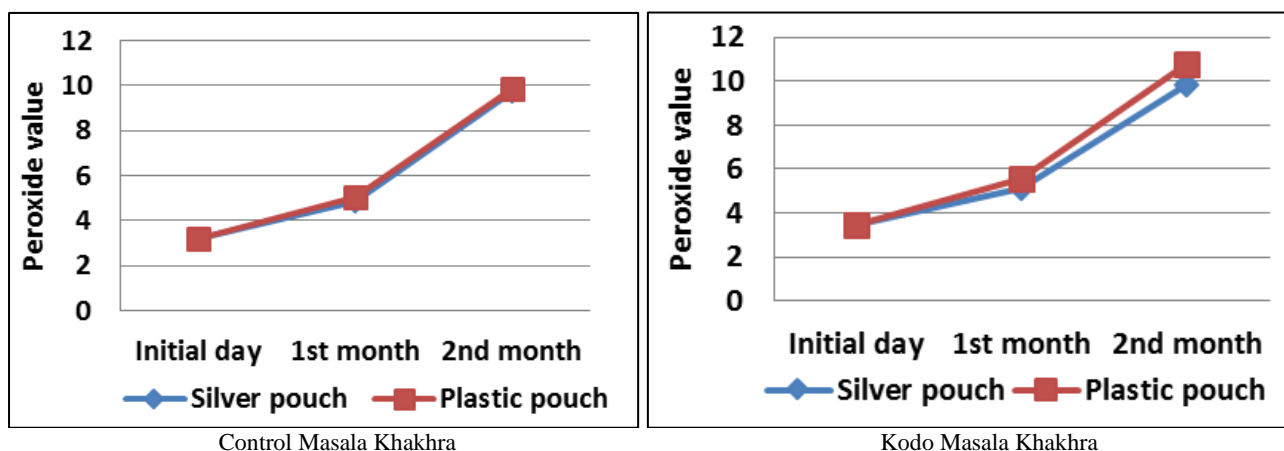


Fig 7: Peroxide Values (Meq O₂/Kg) of Masala Khakhra on Storage

Fig.7 denotes the peroxide values of masala khakhra on storage. On initial day peroxide values of KMK6 stored in silver pouch was significantly high compared to plastic

pouch. The increase in peroxide value of control khakhra when stored in silver pouch was from 3.19 to 9.71%, and in plastic pouch 3.21 to 9.85%. In kodo masala khakhra, it was

observed that peroxide value increased from 3.47 to 9.86% in silver pouch and 3.44 to 10.09% in plastic pouch. However,

peroxide values in both the storage pouches were within acceptable level.

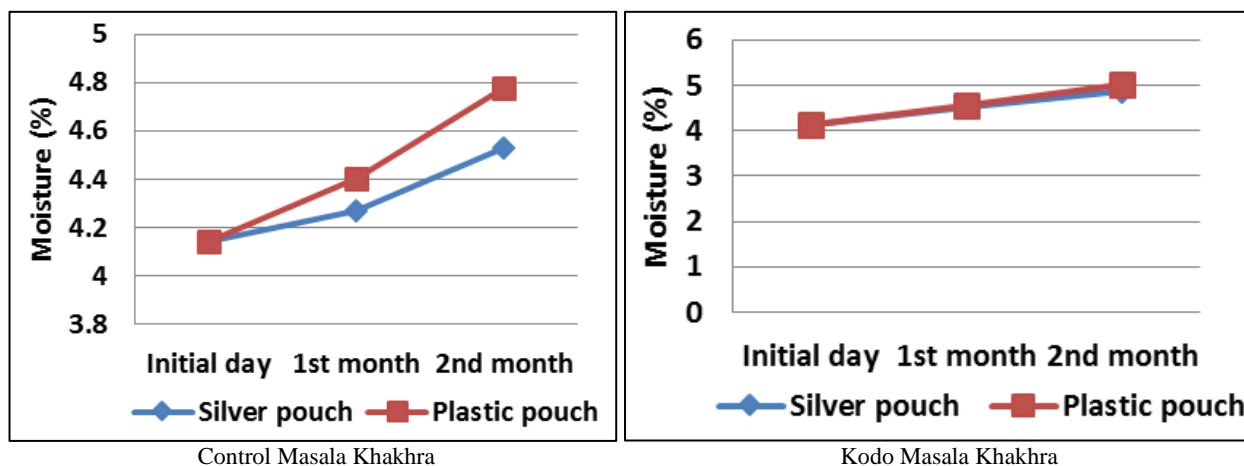


Fig 8: Moisture (%) Of Masala Khakhra on Storage

Fig 8. depicts the moisture (%) of masala khakhra on storage. Control masala khakhra stored in silver pouch showed significant increase of 4.14 to 4.53% (0 day to 60th day) and control masala khakhra stored in plastic pouch showed significant increase from 4.14 to 4.78% (0 day to 60th day). Further, kodo masala khakhra stored in silver pouch showed significant increase of 4.11 to 4.86% (0 day to 60th day) and

kodo masala khakhra stored in plastic pouch showed significant increase from 4.14 to 5.02% (0 day to 60th day). Similar findings were observed by Solanke G.M *et al.*, 2020 [23] and authors reported that increase in moisture content during storage period is because of hygroscopic nature of whole wheat flour and other factors such as temperature, relative humidity present in air.

Table 6: Organoleptic Scores of Masala Khakhra on Storage

Storage Material	Variations	Duration	Sensory Attributes					Overall acceptability
			Appearance	Colour	Texture	Aroma	Taste	
Silver pouch	CMK	Initial	8.50±0.67	8.54±0.66	8.58±0.67	8.25±0.75	8.33±0.89	8.50±0.52
		30 th day	7.00±0.95	7.50±0.67	7.67±0.49	7.17±0.72	7.17±0.94	7.33±0.49
		60 th day	6.75±1.06	7.00±0.60	7.00±0.74	5.58±1.00	6.33±1.44	6.17±1.03
		F value	**	**	**	**	**	**
		SEm±	0.2623	0.1862	0.1852	0.2401	0.3218	0.2092
		CD (5%)	0.7548	0.5357	0.5329	0.6909	0.9258	0.6020
	KMK6	Initial	7.58±1.00	7.46±0.94	7.50±0.67	7.17±1.19	7.25±1.06	7.04±1.14
		30 th day	6.58±1.00	6.50±1.00	6.42±0.67	6.17±1.19	5.75±0.87	6.58±0.79
		60 th day	6.08±1.00	6.17±0.72	6.33±0.78	5.50±0.80	5.33±0.49	6.00±0.85
		F value	**	**	**	**	**	**
		SEm±	0.2876	0.2582	0.2046	0.3111	0.2419	0.2713
		CD (5%)	0.8274	0.7428	0.5888	0.8952	0.6959	0.7806
Plastic pouch	CMK	Initial	8.42±0.79	8.46±0.78	8.50±0.67	8.17±0.72	8.25±0.87	8.50±0.52
		30 th day	7.08±0.90	7.42±0.67	7.58±0.51	7.08±0.67	7.08±0.90	7.42±0.67
		60 th day	6.67±1.07	6.92±0.67	6.92±0.67	5.67±1.07	6.08±1.38	6.00±1.13
		F value	**	**	**	**	**	**
		SEm±	0.2683	0.2045	0.1800	0.2423	0.3101	0.2353
		CD (5%)	0.7719	0.5884	0.5180	0.6972	0.8923	0.6769
	KMK6	Initial	7.50±1.09	7.38±1.03	7.42±0.67	7.08±1.24	7.17±1.11	7.00±1.21
		30 th day	6.67±0.98	6.42±0.90	6.33±0.65	6.00±1.13	6.00±0.74	6.42±0.79
		60 th day	6.00±0.95	6.08±0.67	6.25±0.75	5.42±0.67	5.42±0.51	6.00±0.74
		F value	**	**	**	**	**	**
		SEm±	0.2916	0.2532	0.2000	0.3008	0.2388	0.2702
		CD (5%)	0.8389	0.7286	0.5753	0.8655	0.6871	0.7775

*significant at $p < 0.05\%$ **significant at $p < 0.01\%$

Table 6 shows the organoleptic scores of masala khakhra on storage. Upto 30th day sensory scores were between like moderately to like very much. Off flavour was observed in masala khakhra on 60th day. Because of this reason on 60th day sensory scores significantly reduced in both control and kodo masala khakhra stored in silver as well as plastic pouches.

Control masala khakhra stored in silver pouch appearance scores reduced from 8.50 to 6.75, colour from 8.54 to 7.00,

texture 8.58 to 7.00, aroma 8.25 to 5.58, taste 8.33 to 6.33 and overall acceptability from 8.50 to 6.17. KMK6 scores got reduced for appearance from 7.58 to 6.08, for colour 7.46 to 6.17, texture 7.50 to 6.33, aroma 7.17 to 5.50, taste 7.25 to 5.33 and overall acceptability 7.04 to 6.00.

In plastic pouch also, control masala khakhra scores got reduced for appearance from 8.42 to 6.67, for colour 8.46 to 6.92, texture 8.50 to 6.92, aroma 8.17 to 5.67, taste 8.25 to 6.08 and overall acceptability 8.50 to 6.00. For kodo masala

khakhra scores reduced for appearance from 7.50 to 6.00, for colour 7.38 to 6.08, texture 7.42 to 6.25, aroma 7.08 to 5.42, taste 7.17 to 5.42 and overall acceptability 7.00 to 6.00. Thus, on 60th day, the overall acceptability was 7.04 to 6.00 and 7.00 to 6.00 for kodo masala khakhra stored in silver and plastic pouches.

Table 7: Microbial Load of Value Added Masala Khakhra:

Organisms	Variations	Duration		
		Initial day	30 th day	60 th day
Bacteria ($\times 10^2$ cfu/g)	CMK (SP)	0.00(0.707)	0.00(0.707)	0.33(0.911)
	KMK6 (SP)	0.00(0.707)	0.00(0.707)	0.66(1.077)
	CMK (PP)	0.00(0.707)	0.00(0.707)	0.66 (1.077)
	KMK6 (PP)	0.00(0.707)	0.00(0.707)	0.66 (1.077)
Fungi ($\times 10^2$ cfu/g)	CMK (SP)	0.00(0.707)	0.00(0.707)	0.00(0.707)
	KMK6 (SP)	0.00(0.707)	0.00(0.707)	0.00(0.707)
	CMK (PP)	0.00(0.707)	0.00(0.707)	0.00(0.707)
	KMK6 (PP)	0.00(0.707)	0.00(0.707)	0.00(0.707)
Coliforms ($\times 10^2$ cfu/g)	CMK (SP)	0.00(0.707)	0.00(0.707)	0.00(0.707)
	KMK6 (SP)	0.00(0.707)	0.00(0.707)	0.00(0.707)
	CMK (PP)	0.00(0.707)	0.00(0.707)	0.00(0.707)
	KMK6 (PP)	0.00(0.707)	0.00(0.707)	0.00(0.707)

CMK (SP)-Control Masala khakhra (silver pouch), KMK (SP)-Kodo Masala Khakhra (silver pouch)

CMK (PP)-Control Masala khakhra (plastic pouch), KMK (PP)-Kodo Masala Khakhra (plastic pouch),

Values in parenthesis indicate ($\sqrt{x + 0.5}$)

Table 7 denotes the microbial load of value added masala khakhra. There was no growth of any kind of microorganisms on initial to 30th day of storage both in silver pouch and plastic pouch packed products. But bacteria started to grow on 60th day in products i.e. both control and kodo masala khakhra packed in silver as well as plastic pouches. However, Fungi and coliforms were not observed. Even bacterial load was within permissible safe limits. This is because of the low moisture content of khakhra. Similar results were observed by Giridhar P., 2019^[17].

Thus, the results showed that masala khakhra can be safely stored for 60 days at ambient temperature in plastic or silver pouches.

Conclusion

Since millets are climate resilient, nutritionally superior and healthy, with development of value added products from millets, their nutritional and health benefits can be exploited. From the study, it is clear that acceptable shelf stable value added products can be developed from kodo millet. Moreover, a food rich in protein, fiber, minerals and less in fat is a choice of health conscious people. In present study with incorporation of kodo, fat and energy contents have reduced and fiber contents have increased in kodo masala khakhra. However, it is necessary to popularize these value added products among all sectors of the population.

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