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Formulation and Evaluation of Pulav Prepared from Kodo Millet (*Paspalum scrobiculatum*)

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A B S T R A C T

Kodo millet is a nutritious grain and a good substitute to rice and wheat. Vegetable Pulav is one of the traditional cuisine of the South India. Kodo millet pulav was developed by incorporating kodo millet with broken rice at different variations of 50, 75 and 100 per cent. As per sensory evaluation results 50 per cent incorporated kodo millet pulav was found to be highly acceptable compared to the other variations and selected for developing Ready to cook (RTC) Kodo millet pulav mix using Kodo millet rice, dehydrated vegetables, oil and spices. The developed pulav mix had proten11.53g, 1.9 g of minerals, crude fibre14.27 g , calcium 102 mg, iron 5.32 mg, magnesium 132.67 mg, zinc 2.46 mg, copper 0.43 mg and manganese 0.52 mg per 100g. Shelf life evaluation showed that decreased sensory scores increased moisture content (5.39 to 8.50 per cent), free fatty acid (2.33 to 3.19 per cent), peroxide value (1.20 to 2.15meq O2/kg) and microbial load was within safe limit in the kodo millet incorporated ready to cook pulav mix upto 90 days.

Introduction

Millets are one of the oldest foods known to humans and possibly the first cereal grain to be used for domestic purposes. Millets are small-seeded grasses that are hardy and grow well in dry zones as rain-fed crops under marginal conditions of soil fertility and moisture (Bommy and Kavitha, 2016). Millets are unique because of their richness in calcium, dietary fibre, polyphenols, carbohydrates (70-80%) and protein (9-14%). It is a gluten-free cereal and also rich in phytochemicals which help to lower cholesterol level and reduced cancer risk due to its phytate content (Shadang and Jaganathan, 2014). Global millet production was estimated as 27.83 million tons (FAO, 2014). An estimation says Kodo millet is grown in area of about 907,800 ha with annual production of about 310,710 tonnes (Yadav *et al.*, 2013). Once a poor man's staple, now adorns the plates of affluent and health conscious people. One of such ancient millet grains is kodo millet, a native of tropical Africa, believed to be domesticated in

India about 3000 years back. Kodo is also described as nutritious millet and has received far less research and development attention than other crops with regard to crop improvement and utilization. Nutritionally Kodo millet a fair source of protein, which is highly digestible and is an excellent source of dietary fibre with good amounts of soluble and insoluble fractions. The carbohydrate content is low and slowly digestible (Deshpande *et al.,* 2015). A fast paced urban lifestyle, increasing dominance of nuclear family structure, rising disposable income, convenience of use have made RTE foods popular. Provision of such RTE foods based on nutritious grains such as millets would be more meaningful in the modern times in the management of life style disorders (Takhellamban *et al.,* 2015). Considering the above mentioned nutritional and health benefits of millets, a research study was conducted to formulate and standardize the pulav from dehulled kodo millet with broken rice at different incorporation levels and also to standardize and to assess the shelf life of formulated ready to cook pulav mix.

Materials and Methods

Procurement of raw materials

Kodo millet was procured from the local farmers of Gopalanahalli of Chikkanayakanahalli taluk of Tumkur district of Karnataka, India. The grains were cleaned and dehulled in Millet Processing unit of Farmers Grower's Association, Gopalanahalli of Tumkur district. The grains were cleaned to remove dust, other foreign materials, used to standardize the pulav and for proximate analysis.

Formulation of Kodo millet pulav

Kodo millet Pulav was standardized by incorporating kodo millet rice with broken rice at 50% (KPT1), 75% (KPT2), and 100% (KPT3) and control pulav was prepared from 100% broken rice (KPC). The ingredients used for the preparation of the pulav are given in Table 1.

The flow chart for preparation of pulav is given in Figure 1.

Sensory evaluation

Sensory evaluation of the control and all the variations was done with the help of nine point hedonic scale by a panel of twenty one semitrained judges.

Ready to cook (RTC) Kodo millet pulav mix

The best accepted product variation was selected for the development of pulav mix KPT1 (50%).The soaked (one hour) and dried Kodo millet rice (50 g) and broken rice (50g), total of 100 g mixed rice were roasted in stainless steel on flame with constant stirring till the roast attained 150 ± 3º C and started to give characteristics aroma and colour of a cooked product. Oil (15 ml) was heated (180 ± 5 °C) in a pan, spices and vegetables namely cinnamon (1 inch pieces 2 nos), cardomum (2 nos), clove (2 nos), pepper (4 nos), dehydrated ginger garlic powder (2.5 g), peas (8 g), onion (5 g), chilli (1 g), potato (8 g), carrot (4 g), beans (4 g), mint leaves (1.25 g), coriander leaves (2 g) were shallow fried. Preprocessed and roasted kodo millet rice and broken rice were added in the pan and mixed properly with oil. Salt (2.5 g) was added to the contents of the pan. The samples were cooled and packed in Aluminium pouches and stored at ambient condition (20–35 °C).

Pulav from RTC pulav mix

To the one cup of Kodo millet pulav mix three cups of water was boiled in pressure

cooker. kodo millet pulav mix and salt were added to boiling water and it was cooked for three whistles.

Nutrient composition of pulav mixes

All analysis were done by following the AOAC (1980) official protocols. Moisture was determined from sample weight loss after drying at 110° C for 4 h. Protein (g) content was determined by Kjeldahl method. The Soxhlet method was used for total fat (g) determination. Crude fiber was estimated by treatment of sample first with acid and subsequently with alkali. The loss in weight was the crude fibre content. Carbohydrate and energy by difference method (Livesey, 1995). Ash by muffle furnace, micronutrients (mg) iron, zinc and copper by using Atomic Absorption Spectrophotometer and calcium and magnesium by titration method. All samples were analyzed in triplicates.

Storage quality evaluation

The Control and kodo millet pulav mixes were packed in Aluminium pouches, heat sealed and stored in cardboard boxes at ambient temperature for a period of 90 days. The storage quality of Control pulav mix and kodo millet pulav mixes were evaluated for moisture content, free fatty acid (FFA), peroxide value (PV), sensory quality and microbial population at the interval of 30 days for a period of 90 days. Sensory evaluation was carried out for the stored product in the form of cooked pulav.

Statistical analysis

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

Results and Discussion

Sensory evaluation of formulated products

The mean scores of pulav prepared from kodo millet incorporated with broken rice is depicted in Table 2. Control pulav had the highest scores for all the sensory parameters. Among the variations highest scores for appearance, colour, flavour, texture, taste and overall acceptability (7.98, 7.98, 8.07, 7.89, 8.08 and 8.11 respectively) were recorded for 50 per cent kodo millet incorporated pulav KPT1 and least scores was for 100% Kodo millet incorporated variation i.e. KPT3 However, the difference in scores for all the sensory parameters among the variations was found to be statistically significant (Figure 2).

Mohana Vidhya and Roobhadevi (2014) formulated and standardized ready to cook mixes by incorporating kodo millet at 10%, 20% and 30% respectively and assessed the shelf life and reported that ready to cook mixes with kodo millet were highly acceptable.

Table 3 shows nutrient composition per 100gpulav mix. It was found that the protein content of kodo millet based pulav was higher (10.00 ± 0.1) than the control pulav (11.53 ± 0.15). Control *pulav* had relatively higher carbohydrate content (65.97g ± 0.32). Carbohydrate in kodo millet pulav was observed to be 60.39g±0.64. Fat content of kodo millet and control *pulav* were 5.20 ± 0.17 and 6.06 ± 0.20. Calcium content was also higher in millet based *pulav (*102.00 ± 2.00*)* than control pulav (86.00 ± 1.73). Iron, magnesium, zinc, copper and manganese content of kodo millet pulav were 5.32 ± 0.33, 132.67 ± 1.15, 2.46 ± 0.37, 0.43 ± 0.02 & 0.52 ± 0.04 and control *pulav* were 3.11 ± 0.18, 91.00 ± 1.00, 1.77 ± 0.11, 0.28 ± 0.06& 0.71 ± 0.09 respectively. Study conducted by Verma *et al.,* 2015 also concluded that *biryani*

prepared from barnyard millet and foxtail millet had higher contents of protein, fat, fibre, calcium and iron as compared to biryani prepared from rice (control).

Table 4 depicts the sensory scores of pulav during storage. As expected the scores for sensory attributes decreased as the number of days of storage increased. The decrease in appearance was significant from initial to 30th (8.40) and 60th (7.36) day. But the decrease from 60th to 90th was not significant (7.36 and 7.32 respectively).Where as in kodo millet pulav appearance did not changed upto 30th day (8.39 and 8.17), but decreased significantly from 30th day to 60th day and 90th day (7.29 and 7.07 respectively), but change is not significant on 60th and 90th day. Texture (8.43 and 8.16), colour (8.53 and 8.22) and flavor (8.48 and 7.99) decreased but it was not significant in control pulav from initial to 30th day but decreased significantly from 30th day to 60th day and 90th day. Taste in control pulav decreased significantly from initial (8.31) to 90th day (7.64) (Figure 3 and Figure 4).

Table.1 Ingredients used in the preparation of control and Kodo millet Pulavs

Ingredients	Control	Variations		
	KPC	KPT1 (50%)	KPT2(75%)	KPT3(100%)
Broken rice	40g	20g	10g	-
Kodo millet rice	-	20g	30g	40g
Oil	10ml	10ml	10ml	10ml
Spices	5g	5g	5g	5g
Ginger garlic paste	1 tsp	1 tsp	1 tsp	1 tsp
Onion	20g	20g	20g	20g
Green Chillies	5g	5g	5g	5g
Potato	20g	20g	20g	20g
Carrot	20g	20g	20g	20g
Peas	20g	20g	20g	20g
mint leaves	1g	1g	1g	1g
Salt	1g	1g	1g	1g

Table.2 Mean sensory scores of Kodo millet Pulav

Products	Sensory attributes					
	Appearance	Colour	Flavour	Texture	Taste	Overall acceptability
KPC (Control)	8.33	8.29	8.29	8.19	8.33	8.29
KPT1 (50%)	7.98	7.98	8.07	7.89	8.08	8.11
KPT2 (75%)	7.68	7.60	7.81	7.82	8.04	7.84
KPT3 (100%)	7.19	7.10	7.43	7.29	7.49	7.35
F Value	*	*	*	*	*	*
SE(m)	0.21	0.21	0.17	0.17	0.48	0.17
C.D at 5%	0.59	0.58	0.48	0.47	0.16	0.48

*significant

*$P \leq 0.05$, Values in the same column bearing different superscripts are significantly different

KPC – Pulav control, KPT1 -Kodo millet pulav treatment (50%), KPT12-Kodo millet pulav treatment (75%), KPT3-Kodo millet pulav treatment (100%)

Table.3 Nutrient composition of Kodo millet Pulav mix (KPT1)

Nutrients	Pulav mix per 100 g	
	Control Pulav mix (KPC)	KodoPulav mix (KPT 50%)
Moisture (g)	6.49±0.15	5.83±0.59
Fat (g)	5.20±0.17	6.06±0.20
Protein (g)	10.00±0.1	11.53±0.15
Ash (g)	1.62±0.10	1.9±0.03
Crude fibre (g)	10.53±0.28	14.27±0.74
Carbohydrate (g)	65.97±0.32	60.39±0.64
Energy (Kcal)	350.68±2.32	341.68±1.85
Calcium (mg)	86.00±1.73	102.00±2.00
Iron (mg)	3.11±0.18	5.32±0.33
Magnesium (mg)	91.00±1.00	132.67±1.15
Zinc (mg)	1.77±0.11	2.46±0.37
Copper (mg)	0.28±0.06	0.43±0.02
Manganese (mg)	0.71±0.09	0.52±0.04

Values are mean of three triplicates ± SD

Table.4 Mean sensory scores of Pulavs during storage study

Products	Duration	Sensory attributes					
		Appearance	Texture	Colour	Flavour	Taste	Overall acceptability
KPC	Initial	8.40^{a}	8.43^{a}	8.53^{a}	8.48^{a}	8.31^{a}	8.29^{a}
	30th day	8.00^{b}	$8..16^{a}$	8.22^{a}	7.99^{a}	8.12^{bc}	8.19^{a}
	60th day	7.36^{cd}	7.53^{b}	7.58^{bc}	7.57^{bc}	7.86^{cd}	7.43^{bc}
	90th day	7.32^{d}	7.17^{c}	7.43^{c}	7.02^{c}	7.64^{d}	7.27^{c}
	F value	*	*	*	*	*	*
	SE(m)	0.13	0.10	0.12	0.15	0.12	0.14
	CD	0.38	0.28	0.34	0.42	0.36	0.39
KPT	Initial	8.39^{a}	8.19^{a}	8.51^{a}	8.41^{a}	8.38^{a}	8.32^{a}
	30th day	8.17^{a}	7.96^{a}	8.12^{a}	8.00^{a}	7.87^{bcd}	8.25^{a}
	60th day	7.29^{bc}	7.23^{bc}	7.52^{bc}	7.45^{bc}	7.76^{cd}	7.81^{ab}
	90th day	7.07^{c}	7.01^{c}	7.21^{c}	7.07^{c}	7.44^{d}	7.55^{b}
	F value	*	*	*	*	*	*
	SE(m)	0.11	0.15	0.158	0.19	0.16	0.18
	CD	0.29	0.41	0.44	0.53	0.45	0.51

*significant

*$P \leq 0.05$, Values in the same column bearing different superscripts are significantly different

KPC – Pulav control, KPT-Kodo millet pulav treatment (50%)

Table.5 Moisture, Free fatty acids and peroxide value of control and kodo millet pulav on storage

Products	Duration	Moisture (%))	FFA (%)	PV(meq 2/kg
KPC	Initial	6.84^{a}	1.33^{a}	0.42^{a}
	30^{th} day	7.26^{a}	1.66^{bc}	1.01^{a}
	60^{th} day	8.94^{bc}	1.84^{c}	1.24^{b}
	90^{th} day	9.46^{c}	2.32^{d}	1.47^{c}
	F value	*	*	*
	SE(m)	0.16	0.08	0.05
	C.D.	0.54	0.28	0.17
KPT	Initial	5.39^{a}	2.33^{a}	1.20^{a}
	30^{th} day	6.06^{a}	2.66^{b}	1.27^{a}
	60^{th} day	7.64^{bc}	3.05^{cd}	1.38^{a}
	90^{th} day	8.50^{c}	3.19^{d}	2.15^{b}
	F value	*	*	*
	SE(m)	0.34	0.08	0.09
	C.D.	1.10	0.28	0.31

*significant

*$P \leq 0.05$, Values in the same column bearing different superscripts are significantly different

KPC – Pulav control, KPT-Kodo millet pulav treatment (50%)

Table.6 Microbial population of control and kodo millet pulav on storage

Products	Duration (days)	Population of microorganisms		
		Bacteria ($x10^{4}$cfu/g)	Funngi ($x10^{2}$cfu/g)	Coliforms ($x10^{2}$cfu/g)
KPC	Initial	0.67^{a} (1.081)	0.00 (0.707)	0.00 (0.707)
	30^{th} day	1.77^{b}(1.506)	0.00 (0.707)	0.0 0(0.707)
	60^{th} day	2.13^{c} (1.621)	0.00 (0.707)	0.00 (0.707)
	90^{th} day	3.67^{d} (2.042)	0.00 (0.707)	0.00 (0.707)
	F value	*	NS	NS
	SE(m)	0.04	0.00	0.00
	CD at 5%	0.15	-	-
KPT	Initial	0.33^{a} (0.911)	0.00(0.707)	0.00(0.707)
	30^{th} day	1.77^{b}(1.506)	0.00(0.707)	0.00(0.707)
	60^{th} day	3.20^{c} (1.923)	0.00(0.707)	0.00(0.707)
	90^{th} day	3.60^{d} (2.024)	0.00(0.707)	0.00(0.707)
	F value	*	NS	NS
	SE(m)	.04	0.00	0.00
	CD at 5%	0.14	-	-

*-Significant, NS- Non significant

*$P \leq 0.05$, Values in the same column bearing different superscripts are significantly different

KPC – Pulav control, KPT-Kodo millet pulav treatment (50%)

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

Fig.1 Flow chart for the preparation of Pulav

Grains were washed and soaked for one hour

↓

Oil was heated in a pan and spices and onion were added and fried till soft

↓

Green chillies and ginger garlic paste were added and fried for 3-4 minutes

↓

Chopped vegetables, mint leaves and salt were added and fried for a minute

↓

Required quantity of water was added

↓

Kodo millet rice was added to boiling water and mixed well

↓

It was cooked in pressure cooker till 3 whistles

Fig.2 Mean sensory scores of Kodo millet pulav

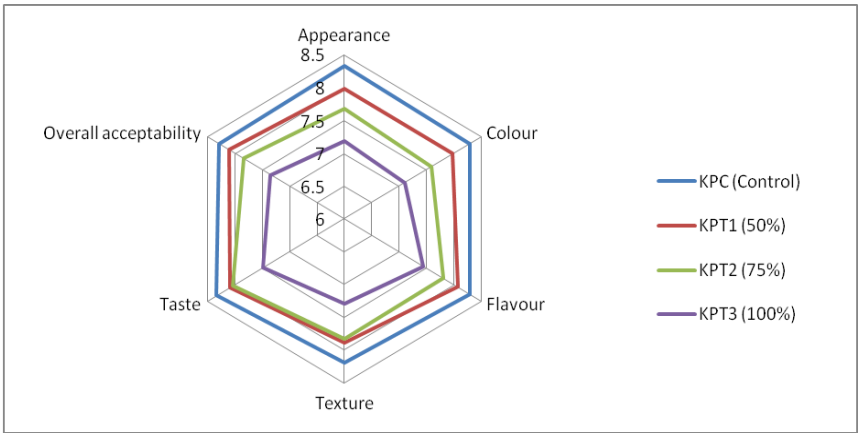


Fig.3 Mean sensory scores of Control pulav

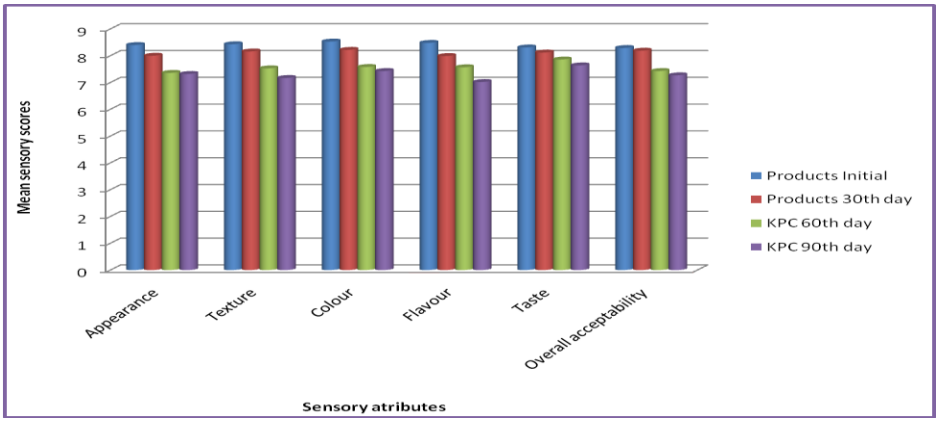
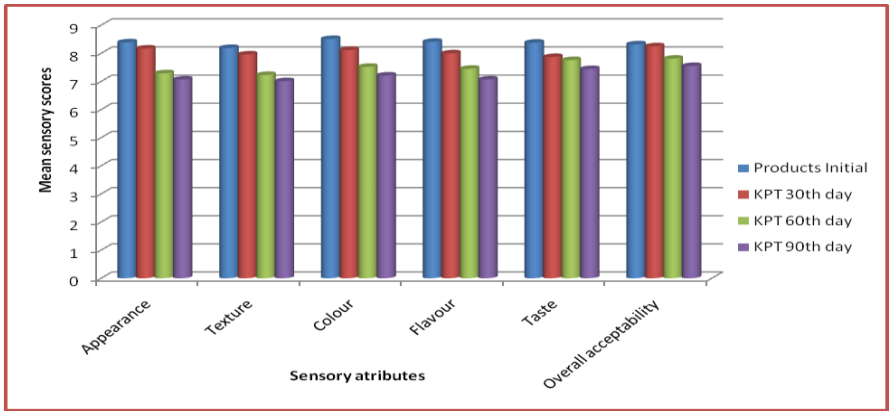


Fig.4 Mean sensory scores of kodo millet pulav



However, over all acceptability did not change from initial to 30th day (8.29 and 8.19), but decreased significantly from 30th day to 90th day (7.43 and 7.27). In kodo millet pulav appearance (8.39 and 8.17), texture (8.19 and 7.96), colour (8.51 and 8.12) and flavor (8.41 and 8.00)did not change from initial to 30th day, but decreased significantly from 60th (7.29, 7.23, 7.52 and 7.45) day to 90th day (7.07, 7.01, 7.21 and 7.07). Taste of kodo millet pulav decreased significantly from initial to 90th day (8.38 to 7.44). The over all acceptability did not change upto to 60th day (8.32, 8.25 and 7.81 respectively), but decreased significantly on 90th day (7.55). Kavita *et al.,* 2015 also reported that the taste and aroma scores for *avalakki* were 7.20 each on initial storage period which did not change till 5th month of storage (6.60 and 6.40, respectively). However, on 6th month the scores decreased gradually (5.70 and 5.60, respectively), but the flakes were acceptable till the end of 6th month.

Effect of storage on moisture, Free fatty acid content and peroxide value for control and kodo millet pulav is given in Table 5.Moisture content did not change from initial (6.84% and 7.26%) to 30th day (5.39% and 6.06%), but increased significantly ($p<0.05$) on 60th(8.94% and 7.64%) and 90th day (9.46% and 8.50%) in both the products. Storage of pulav for 90 days at ambient temperature significantly ($p<0.05$) increased the FFA content from 1.33 (Initial) to 2.32 per cent in control pulav and 2.33 (Initial storage) to 3.19 per cent in kodo millet pulav (KPT) on 90thday of storage. Free fatty acid content between storage durationof30th day and 60th day in control pulav and between 60th day and 90th day in kodo millet pulav was not significant. Peroxide value (PV) of extracted lipids increased significantly ($p<0.05$) from 0.42 (Initial day) to 1.47(90thday) meq O_2 per kg in control pulav and 1.20 (Initial) to 2.15(90th day) meq O_2 per kg in kodo millet pulav. PV between storage duration between initial day and 30th day in control pulav and storage duration between initial day, 30th day and 60th day in kodo millet pulav was not significant. Similar study was by Kavita *et al.,* (2015) who reported that little millet flakes showed a small increase in moisture uptake during storage from 10.11 % (0 month) to 11.82 % (6th month). Free fatty acid content increased from 9.20% (0 m) to 18.02 % (6th month).

Microbial population of control and kodo millet pulav on storage at different intervals for bacteria, fungi and *coliforms* by standard plate count is presented in Table 6. Bacterial count increased significantly from initial day of storage to 90th day of storage in control

pulav (0.67, 1.77, 2.13 and 3.67 x10^4cfu/g respectively) and also in kodo millet pulav (0.33, 1.77, 3.2 and 3.60x10^4 cfu/g). There were no mould colonies and coliform colonies reported in control and kodo millet pulav from initial day to 90th day of storage. Similar finding were noted by Mohana Vidhya and Roobhadevi, 2014 that at the initial stage, the colony formation (*Streptococci* sp) was very low in all the ready to cook mixes and there was a slight increase in the bacterial count on the 45th day of storage, however the levels of the bacterial count was within the recommended standard.

In conclusion the RTC Kodo millet pulav thus not only convenient but also found to be rich in fibre and micro nutrients like calcium and iron. Shelf life study revealed that it is safe for consumption till 90 days of storage. Hence, from the present study it can be concluded that acceptable pulav can be developed with kodo millet without affecting the sensory qualities and health benefits of Kodo millet can be exploited.

The best accepted product variation was selected for the development of pulav mix KPT1 (50%). The soaked (one hour) and dried Kodo millet rice (50 g) and rice grits (50g), total of 100 g mixed rice were roasted in stainless steel on flame with constant stirring till the roast attained 150 ± 3 °C and started to give characteristics aroma and colour of a cooked product. Oil (15 ml) was heated (180 ± 5 °C) in a pan spices and vegetables namely cinnamon (1 inch pieces 2 nos), cardomum (2 nos), clove (2 nos), pepper (4 nos), dehydrated ginger garlic powder (2.5 g), peas (8 g), onion (5 g), chilli (1 g), potato (8 g), carrot (4g), beans (4g), mint leaves (1.25 g), coriander leaves (2 g) were shallow fried. Preprocessed and roasted kodo millet rice and rice grits were added in the pan and mixed properly with oil. Salt (2.5 g) was added to the contents of the pan. The samples were cooled and packed in Aluminium pouches.

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