Process Standardization and Quality Evaluation of Millet Fortified Papad

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By

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CERTIFICATE – I

*This is to certify that the thesis entitled **"Process Standardization and Quality Evaluation of Millet Fortified Papad"** submitted in partial fulfilment of the requirement for the degree of **MASTER OF SCIENCE IN AGRICULTURE (Food Technology)** Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, is a record of the bonafide research work carried out by **Mrs. Afsharika Azmi Khan** under my guidance and supervision. The subject of the thesis has been approved by the student's Advisory Committee and the Director of Instruction.*

No part of the thesis has been submitted for any other degree or diploma (Certificate awarded etc.) or has been published/published part has been fully acknowledged. All the assistance and help received during the course of investigation has been duly acknowledged by her.

Date- 29/6/2013

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CERTIFICATE – II

*This is certify that the thesis entitled **"Process Standardization and Quality Evaluation of Millet Fortified Papad"** submitted by **Mrs. Afsharika Azmi Khan** to the Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, in partial fulfillment towards the requirements for the degree of **"Master of Science"** in **AGRICULTURE (Food Technology)** has been, after evaluation, approved by the External Examiner and by the Student's Advisory Committee after an oral examination on the same.*

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(*Afsharika azmi*)

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LIST OF ABBREVIATIONS

%	-	Percent
i.e.	-	that is
ha	-	hectare
viz.	-	which is/ are
mg	-	milligram
cm	-	centimeter
g	-	gram
NS	-	Non significant
CD	-	Critical difference
LDPE	-	Low density polyethylene
et al.	-	co-workers
w/v	-	weight/volume
°C	-	degree centigrade
hr.	-	hour
min	-	minute
ml.	-	milligram
SEm	-	Standard error mean
approx	-	approximately

CHAPTER – 1

INTRODUCTION

INTRODUCTION

Papad is a popular food items in Indian diet (Chansoriya, 2005). It is essentially a thin wafer-like product, circular in shape, rolled and nutritious as well. Papad is eaten along with the main course as taste enricher, while farsan is a snack. Papad also known as Appalam is a popular snack and tasty food item in the Indian diet in many centuries, which is regularly consumed as a meal, accompaniment, after roasting or frying or as adjunct along with vegetable soups and curries (Chowdhury *et al*. 2008).

Evolutions in foods, during changing times have amply reflected the culture and socio-economic situations of different periods. Diversity has been the hallmark of Indian food. India has a wealth of traditional foods created over a millennium by over 500 cultures, Indian traditional food sector broadly consists of major snacks such as shelf stable fried products, semi moist fried products, popped cereals, expanded rice & legumes, flaked cereals, extruded snacks, fermented products, sweet snacks & pickles/meal accompaniment (papad) and relatively small segment of ready to serve and instant food mixes.

Papad is a popular and tasty food item in the Indian diet. Since many centuries, combination of pulses, cereals, fruits, roots and tubers used for preparation of papad varies from one region to another depending upon the preference of local people. Market for papad is steadily growing across the country. There are a couple of national brands available but the market is predominantly controlled by the local brands. Black gram is the largest selling papad in the local and national market. During 1988-89 papads worth 64 millions were exported in comparisons to 3343 tonnes worth Rs. 49 millions 1986-87 (Kulkarni *et al*. 1996). Manufacturing of papad is yet to pick up and prospects for new types of papads are bright provided good quality is maintained and prices are competitive. So, there is a greater scope for introduction of varieties prepared from cost effective raw ingredient.

In recent years great need is felt revive our traditional food sector mainly to provide impetus and value addition for sustainable development of its largely cottage, tiny and rural sector. Hence, the importance of Indian traditional food industry cannot be ignored our food technology and food engineering need to keep pace in meeting the cutting edge requirement in the global context. It is high time that organized sector takes initiative in development and improvement of traditional food technology, automation of manufacturing process, investment in research and development to develop products with enhanced quality & shelf life.

Kodo is important millet of Madhya Pradesh and being cultivated 813.6 ha producing 210.1 tonnes (Agriculture statistic 1998). It is also grown in substantial quantity in Karnataka, Maharashtra, Andhra Pradesh and Uttar Pradesh. Kodo grain is easily preserved and proves as a good famine reserve. The grain is recommended as a substitute for rice to patients suffering from diabetes disease. The grain contains 8.3 percent protein,1.4 percent fat, 65.6 percent carbohydrates , 2.9 percent ash , 15 g fibre, 27 mg calcium,188 mg phosphorus and provides energy kcal 353.It has not yet found its industrial use inspite of its nutritional richness. Kodo is an important component of the diet of rural people of Madhya Pradesh. Almost all the produce is utilized as food but it can found its alternate use. It is used as a cooked rice and thin porridge.

Little millet (*Panicum miliare*) was domesticated in India. The grains of little millet are smaller than those of common millet. It is cultivated 2.91 lakh hectare area. In Madhya Pradesh (1989-90) minor millets area are 1248 million ha and productivity is 2016 kg/ha. Major growing states are Karnataka, Tamil Nadu, Andhra Pradesh, Madhya Pradesh, Jharkhand, Orissa and Maharashtra. The grain contains 8.7

percent protein, 5.3 percent fat, 65.7 percent carbohydrate, 5.4 percent ash, 12.0 g fibre, 17 mg calcium, 220 mg phosphorus and provides energy 329 kcal. Generally it is used as a cooked rice, kheer, thin porridge, dosa, sattu, halwa.

Rice is the staple food for 2.5 billion people. Rice provides 21% of global human capita energy and 15% of per capita protein. 85 of the rice that is produced in the world is used for direct human consumption, Rice can also be found in cereals, snacks foods, brewed beverages, flour, oil, syrup, and religious ceremonies to name a few other uses. 100 gram rice grain contains 6.8 g protein, 0.5 g fat, 78.2 g carbohydrate, 0.6 g minerals, 10 mg calcium, 0.2 g fibre and provides 345 kcal energy.

Soybean has great potential as an exceptionally nutritive and very rich protein food. It can supply the much needed protein to human diets because it contains above 40% protein of superior quality and all the essential amino acids particularly glycine, tryptophan and lysine, similar to cow's milk & animal proteins. Soybean also contains about 20% oil with an important fatty acid, lecithin & vitamin A & D. The 4% minerals salts of soybeans are fairly rich in phosphorus & calcium.

Green gram *(Vigna radiata)* has originated in the India subcontinent. It is grown in about 3.3 million ha. in India with a total production of 1.37 million tonne. Among the states growing this crop Orissa ranks first in area and production. 100 gram green gram contains nutrient is Energy 1452 KJ (347 Kcal), carbohydrate 62.62 g , fat 1.15 g , protein 23.86 g , vitamin C 4.8 mg , calcium 132 mg , magnesium 189 mg , phosphorus 367 mg , potassium 1246 mg and sodium 15 mg.

Tapioca sago is generally known as sago (Sabudana in hindi or javvarishi in tamil) in India. Products from tapioca like starch and sago introduced in India only in 1940's upwards. India is leading countries in tapioca production. Sago is produce, prepared from the milk of tapioca root. It's botanical name is "Manihot Esculenta Crantz Syn. Utilissima". Fresh roots contain about 60-70 % moisture, 7-12 % protein, 5-13 % starch, (32-35 % total carbohydrate) and trace amounts of fat. 100 g sago contains 351 Kcal energy, 87 g carbohydrate, 0.2 g fat and 0.2 g protein. Roasted sago is known as sago common and boiled sago as Nylon sago.

Since production of millet is abundant, there is a need to find diversified uses in order to maximize their utilization and to cater the fast changing taste of new generation. Hence, it was proposed to evaluate the quality characteristics and sensory attributes of indigenous papad prepared from different millets (kodo and little millet) and supplementation of rice, greengram, sago and soybean.

Objectives -

1. To formulate and develop millets fortified papad.
2. Process standardization blending ratio through sensory evaluation.
3. Quality and sensory evaluation of developed product.
4. To study the shelf life of the products in different packaging materials at room temperature.

CHAPTER – 2

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

In this chapter, an attempt has been made to assimilate the previous works within the framework of present study, which were helpful in interpretation of results. The literature referred to planning and executive of present investigation and for discussion of results. The review has been presented as follows.

Jonhson (1970) found that the functional properties have been the function of proteins in different food systems. These include providing acceptable colour, flavour, odour and texture to the food products. Some of the desirable functional properties are easy wettability, good water dispensability and clear dispersion over a wide pH range, desirable viscosity, gel foaming, elasticity, film foaming and aeration properties.

Sood *et al.* (1977) reported that the carbohydrate content was found to vary from 21.6-24.51% among different varieties of soybean.

Patil and Makne (1978) reported that the soybean seeds were found to contain 0.24% calcium, 0.69% phosphorus and 0.011% iron.

Gopalan *et al.* (1980), reported that the sago contains moisture, protein, fat, mineral, and carbohydrate value is 12.2, 0.2, 0.2, 0.3 and 87.1g respectively those provide energy 351 Kcal / 100g of sago.

Narayan and Narsinga Rao (1982) studied that the heat processing increase the fat absorption capacity of soy flour.

Pruthi *et al.* (1982) conducted a storage studies on North Indian spiced urd dhal papads at room temperature (13-38°C and 30-90% RH). About 150 g of papad were packed in low density polyethylene bags (30 x 23 cm) ranging from 100 to 300 gauge. The initial moisture of papad was 13.40 per cent. Mould attacked the papads at 36.50 per cent and 52.10 per cent moisture level at 80 per cent and 90 per cent RH. The papads remained in good conditions upto 14.2o per cent moisture level. No significant change in colour of papads was observed during storage at ambient temperature at different relative humidities (20-90%). Low density polyethylene (LDPE) bags of 200 and 300 gauge were quite suitable for packaging and storage of *papad* for 3 months.

Chaudhary *et al.*, (1984), was investigated that the changes in the oil used for frying papads (wafer like discs prepared from cereals & pulses) containing 0, 3, 5, 6.5, 8.5,10 & 13 % papad khar (crude sodium carbonate) were determined. The rolling property of each of these doughs was also evaluated. There were significant increases in colour intensity, viscosity, acid & peroxide value, iodine value & refractive index of the oils were not significant. Papads with 5 & 6.5 % papad khar were found best to roll. Organoleptically they were rated to contain 5 & 10 % papad khar, respectively.

Pruthi *et al.* (1984) determined the variability in the physico-chemical characteristics of spiced papad of Punjab. Results indicated wide variations in moisture content from 10.70 to 18.20 per cent. Total ash from 8.40 to 11.65 per cent, acid insoluble ash from 0.18 to 0.46 per cent, ether extract from 2.10 to 3.65 per cent, pH from 7.55 to 10.05 and alkalinity of ash from 1.38-3.07 per cent. Analysis of commercial papads also indicate wide variation in average weight (15-24 g), mean diameter (15.80 to 18.60 cm) and mean thickness (0.72 to 1.27 mm) which were in accordance with the existing quality standard.

Saxena *et al.* (1989) studied the possibility of preparation of papads from different dhal (dehusked split pulses) flours with or without the addition of black-gram dhal (*Phaseolus mungo* L.) flour has been examined. Only blends of dhal flours comprising black gram:bengalgram (70:30), black gram:arhar (80:20), black gram:green gram:lentils (60:25:15) and black gram:lentil (80:20) yielded papads with acceptable physico-chemical and sensory quality attributes. The *papad* prepared from the blend of black gram:greengram:lentils (60:25:15) showed better colour, aroma, taste and texture.

Kulkarni et al (1989) investigated that the packaging and storage were conducted on North Indian spiced papads prepared from different blends of black gram, Bengal gram, lentils, red gram and green gram. Equilibrium humidity (ERH) of these papads (initial moisture 13.1-13.6%) ranged from 58.2 to 58.6%. moisture, pH and alkalinity decreased gradually during 4 months storage under ambient conditions. Sensory quality of fried papads remained acceptable up to 4 months.

Neelima and Sarojini (1991) reported that the mean moisture and fat content of the snacks collected from the laboratory prepared samples showing the mean moisture content ranging from 0.95 to 7.53 per cent which might be due to variation in the initial moisture content of the dough/batter and extent of frying. Except in chegodi, the moisture content of other market samples were higher than that of laboratory samples.

Das (1992) reported a slightly higher value of 8.6% crude fiber in roasted soybean seeds.

Deepa *et al.* (1992) studied that the effect of addition of soy flour (10-70%) to black gram papad making, showed no change in the dough texture, though rolling property was affected. Greater amounts of water were needed for mixing the dough with an increase in soy flour concentration. Elasticity was reduced to a minimum at 40% and was completely absent at 50%. Quality characteristics remained the same for both the raw papads. However, the quality of fried papads decreased beyond 60% addition of soy flour. Acceptability decreased with increase in percent soy flour added. The results suggest that an addition of 30-40% of soy flour would not make a significant difference in the physical and sensory characteristics of black gram papad.

Mamtha and Jamuna Prakash (1995) studied that the different levels of defatted rice bran (5, 10, 20 and 30%) were incorporated into two base materials, namely rice flour and sago flour, for making papads. Five different quality parameters were evaluated by 20 trained panelists. The scores were statistically analyzed to determine significant differences between products. The mean scores for color were high for the controls and decreased progressively with an increase in the amount of rice bran added. A similar effect, but to a lesser extent, was seen for texture. The overall quality of product exhibited an influence of color and texture and the products revealed highly significant differences in quality parameters. Since products with a lower level of incorporation were termed as acceptable by panel members, 5–10% of rice bran can be incorporated into the products.

Kulkarni *et al.* (1996) studied the physico-chemical characteristics of commercial spiced papads, being manufactured in Uttar Pradesh, were determined. Data revealed wide variations in moisture content (9.0 to 17.1%), total ash (7.2 to 11.8%), acid insoluble extract (0.18 to 0.52%), alkalinity of ash as Sodium bi carbonate (1.25 to 3.37), ether extract (2.2 to 5.8%) and pH of aqueous extract (7.4 to 9.1). Analysis of physical parameters of papads shows wide variations in mean weight (6 to 24 g), average diameter (9.4 to 21.5 cm) and mean thickness (0.5 to 1.2 mm).

Berwal *et al.*, (1996) studied that the papad was prepared using mixed turkey raw meat and heat treated (50°C/20 min.) turkey meat by blending with rice flour (50:50). The traditional rice papads were used as control. There were significantly ($P<0.05$) increases in protein and fat contents and decrease in ash content in turkey raw meat and heat-treated turkey meat papads, compared to control papads. The % yield and % expansion on frying were ($P<0.05$) for control papads.

Singh *et al.* (1996) studied that the blending of mung flour and addition of sodium bicarbonate significantly increased the gelatinization temperature, but reduced the viscosity. Blending of mung flour in wheat or rice flour and addition the sodium bicarbonate reduced the expansion ratio of papad. The texture of papads significantly increased, due to the addition of sodium bicarbonate. Blending of mung flour in wheat or rice flour, resulted in darker in coloured papads, which was further enhanced by the addition of sodium bicarbonate. Over all acceptability was not affected significantly up to 10% level of blending mung flour with rice and up to 20% with wheat.

Ahamed *et al.* (1997) reports on the oil content of fried noodle-like products prepared from a blend of soya flour and starch in ratios ranging from 80:20 to 20:80 of soya flourstarch.

Keshun lio (1997) reported that the highest protein content (around 40%); other legumes have a protein content between 20% and 30%, whereas cereals have a protein content in the range of 8-15%. The soybean also contains about 20% oil, the second highest content among all food legumes. Other valuable components found in soybeans include phospholipids, vitamins, and minerals.

Dhawan *et al.* (1998) studied the effect of rice flour and defatted soy flour incorporation on the preparation of deep fat fried sev and reported an increase in water absorption, frying time, hardness of the product and expansion ratio. However, soy fortified blends showed higher amount of protein and the oil absorption during frying. Product containing Bengal gram flour, defatted soy flour and rice flour in the ratio of 80:10:10 was found to be most acceptable among the products prepared from various blends.

Chauhan and Tomar (1998) reported that the many promising varieties of soybean were found to contain the total ash in the range of 3.3-6.1%.

Bhattacharya *et al.* (1999) investigated that the papads made with a blend of rice flour (25%) and black gram (75%) closely resembled the product made from black gram alone. The overall acceptability was moderately correlated ($r=0.713$, $p \leq 0.10$) to diametrical expansion and to water absorption capacity ($r = 0.874$, $p \leq 0.01$). A desirable crispy texture in papad can be obtained with a flour having high water absorption values.

Senthil *et al.* (2002) studied that the wheat flour and defatted soya flour blended in the ratio of 65:20, 60:25, 55:30, and 45:40 were studied in respect of dough characteristics and quality of fried savoury and sweet snacks prepared from them. Proportion of soya flour increased in there was a slight increase in water absorption and decrease in dough stability. In fried savoury snacks the protein content increased gradually from 20.75 to 27.50%. When the proportion of soya flour was raised from 20 to 40% in the blend, the corresponding rise in protein content in fried sweet snack was from 15.75 to 21.75%.

Garg and Dahiya (2003) studied that the papads were produced from legume blends, and analysed for sensory acceptability, nutrition quality and keeping quality. Mung flour papads were used as a control and wheat, chickpea and pea flours were used at 10, 20 or 30%, to enrich the mung flour were papads. Papads containing 10% wheat flour, 20% chickpea flour or 10% pea flour were the most acceptable, and were subjected to nutritional evaluation. Protein content significantly increased on enrichment with legume flours at all levels. Fat content was significantly increased on enrichment papads. Ash content varied from 10.17 to 10.78% in papads. Using chickpea flour, total carbohydrates decreased significantly, Cu content increased significantly, and there were significant decreases in contents of phytic acid trypsin inhibitor. Invitro protein digestibility significantly increased on enrichment, while there was a significant decrease in invitro starch digestibility. Results from storage studies showed that chickpea flours enriched papads may be stored safely for 60 days and wheat flour-enriched papads for 30 days at room or refrigeration temperature.

Vidyavati *et al.* (2004) investigated that the papad was prepared by substituting 50% of mixture of black gram dhal flour and sago flour with finger millet flour and compared with blackgram dhal papad for sensory attributes, dough characteristics, rolling properties and nutritional quality. For finger millet flour had higher sensory score of 4.7 on a five point Hedonic Scale. Finger millet papad was rich in Ca (102 mg% in roasted and 109 mg% in fried) compared to blackgram dhal papad (82 mg% in roasted and 99.6% mg% in fried). Substitution of finger millet did not affect the quality characteristics of the papad.

Velu *et al.* (2004) reported that the papad varies by addition of a large number of ingredients such as cereal flour, pulse flour, soya flour, spice mixes, chemical mixes and different vegetable juices to improve both organoleptic and nutritional characteristics. The effect of incorporation of various ingredients namely nalleru (*Cissus quadrangularis*), gum karaya (*Sterculia urens*) and soya flour on diametrical expansion and oil absorption of papads. Papads of 10 cm diameters were deep fat fried at 185 ± 5C after different storage periods up to 60 days. The addition of soya flour reduced the oil absorption.

Reema *et al.* (2004) resulted that soy supplementation significantly improved protein, fat, total and ionisable iron content in all the products. Products prepared from germinated flours showed significant decreases in phytin P and polyphenols with an improvement in starch and protein digestibility

Chansoriya *et al.* (2005) investigated for obtaining best quality papads having optimum dough characteristics, the amount of water required was found to be 45 ml/100 g flour for the dough prepared from black gram flour (BGF) alone, whereas for the dough prepared from a blended combination (BGF: DSF, 50:50), it was 50 ml/100 g flour. The optimum requirement of papad khar was found to be 4-5 g/100 flour obtaining better dough characteristics (rolling property) and best frying quality (diametrical expansion) of papads, irrespective of the blend (with or without defatted soy flour) combination used.

Amudha *et al.*, (2006) studied that the results of analysis revealed perceptible variations in physico-chemical characteristics in both raw and fried papads. The percentage expansion on frying ranged from 32.759/2.73 (S4) to 73.539/3.47 (S3) and the extent of oil absorption varied from 28.309/0.02 (S4) to 49.459/0.03 (S3). The percentage expansion of papads negatively correlated with the moisture content of raw and fried papads (10.86 and /0.76 respectively). Significantly differences were seen in CIE colour parameters, namely L* and a* values between raw and fried samples for S1, S2, S3, S4, S5 and S9 for S3, S4, S6, S10 & S11 respectively, whereas b* values significantly different for all the samples except for the sample S4.

In kodo millet (Millets future of food and farming 2008) contains protein 8.3g/100g, fiber 9g/100g, mineral 2.6g/100g, iron 0.5 mg/100g and calcium 27 mg/100g respectively.

In little millet (Millets future of food and farming 2008) contains protein 7.7g/100g, fiber 7.6g/100g, mineral 1.5g/100g, iron 9.3 mg/100g and calcium 17 mg/100g respectively.

Rahman *et al.* (2008), reported that the five different types of papads were prepared using 0%, 5%, 10%, 15%, 20% soya flour with pulses and other ingredients. The products were analyzed for proximate composition, chemical analysis and self-life evaluation. The moisture, protein, fat, ash and total carbohydrate content in the dried papads samples were found in the range of 10.10 to 10.33%, 24.13 to 28.03%, 1.06 to 5.35%, 1.53 to 1.97% and 54.55 to 62.95%, respectively. No remarkable changes in moisture content, texture and flavour were observed up to 5 months of storage in ambient condition (27 to 35^{0}C) indicating that the products were shelf-stable up to 5 months.

Rahman *et al.* (2008) studied the effects of processing time and temperature on the quality of soya papads. The moisture and fat content in the dried papads samples were found in the range of 10.10 to 10.33% and 1.06 to 5.35% respectively. A sharp increase in fat content was 0.6% ash, 26-36% fat, 28-30% protein and 33.4-42.9% total carbohydrate. The result showed that maximum frying time for dried papads required to reach desired final moisture content of 2-2.5% was 22 sec. at 170°C, 18 sec. at 180°C and 11 sec. at 190°C. The oil content of papads were found to be 23% at 170°C, 20% at 180°C and 16% at 190°C when the moisture content of papads varied from 2-2.5%.

Pawar *et al.* (2009) resulted that the extruded snacks were evaluated for quality attributes such as chemical composition, physical properties and sensory qualities. Snacks contained 11.12% protein, 0.8-1% fat, 3.0-3.2% ash, 1.25-1.40 g/cm^3 bulk density and 1.72-1.77 expansion ratio. The product was fully expanded and well-cooked and uniform in size and shape. The data on sensory quality evaluation showed better quality attributes of the extruded snacks with legume malt than with green gram malt at a ratio of 7:2:1 was better than without legume malt at the same ratio.

Vijayakumari *et al.* (2009), investigated that the composite flour containing kodo *(Paspalum Scrobiculatum)* and barnyard *Millet (Echinochloa colona)* flour, whole wheat flour and defatted soy flour of four different combinations were prepared and studied the impact of *Millet* flour blend incorporation on characteristics of composite flour. Results indicated that wet and dry gluten content, bulk density, WAC, SP decreased significantly ($p<0.05$); level of syneresis and OAC, conclusion gelatinization temperature, gelatinization range (R), protein and crude fiber content were increased significantly at $p<0.05$ with increased proportion of *Millet* flour blend. Due to lower peak viscosity of *Millet* flour blend, the peak viscosities of all composite flour containing *Millet* flour blend were low, compared to the standard composite flour. The setback viscosity was increased with increased proportion of *Millet* flour blend. Thus the analyzed properties of composite flour were significantly modified while increasing the level of incorporation of *Millet* flour blend

Balasubramanium *et al.* (2010), investigated that the minor millets contain moisture content range of 11.1 to 25% db. Thousand kernel weight increased from 2.3 to 6.1 g and angle of repose increased from 25.0 to 38.2°. Bulk density decreased from 868.1 to 477.1 kg/m^3 and true density from 1988.7 to 884.4 kg/m^3 for all minor millets when observed in the moisture range of 11.1 to 25%. Porosity decreased from 63.7 to 32.5%. Coefficient of static friction of minor millets against mild steel surface increased from 0.253 to 0.728 and coefficient of internal friction was in the range of 1.217 and 1.964 in the moisture range studied. Grain hardness decreased from 30.7 to 12.4 for all minor millets when moisture content was increased from 11.1 to 25% db.

Paul *et al.* (2011) results showed that the green gram contained 21.57 g/100g protein, 1.53 g/100g crude fat, 0.63 g/100g crude fiber, 12.07 g/100g moisture, 3.85 g/100g total ash and 60.35 g/100g carbohydrate, respectively. The mineral contents of phosphorus (315.30mg/100g), iron (5.04mg/100g) and calcium (72.89mg/100g) were found in moderate level.

Bhatawale *et al.* (2012) investigated that the effect of incorporation of unripe banana flour on the rheology of dough and textural characteristics of papad with respect to level of resistant starch (RS) in a rice flour papad was investigated. The rice flour was replaced with unripe banana flour with different degrees of substitutions including 0, 20, 40, 60, 80, and 100%. The results indicated that substitution of unripe banana flour significantly affected the hardness and stickiness properties of papad dough. The papad prepared from 100% unripe banana flour indicated significant changes on the textural properties and L* (Lightness) value. The RS value also increased with the degree of substitution. The highest value of sensory score was observed for 75:25 rice : banana flour substitution.

Veena *et al.* (2012) studied that the papad by incorporating different levels of soybean flour, to study the shelf life stability of developed products in different packaging materials for a period of three month at room temperature. Sensory evaluation indicated that the overall acceptability scores of Soy papad at 20% were highest 4.4 for both plastic and steel storage containers. However; it was also found that the acceptability was good for all the levels of Soy products, stored for three months at room temperature. Nutrient composition of stored products in steel containers was comparatively better compared to plastic and polyethylene.

Hossain *et al.* (2012) studied that the present study was undertaken to observe the chemical composition of different types of rice. Moisture content varied from 4.0 to 11.4 g/100g, dry matter content varied from 88.6 to 96.0 g/100g, metabolizable energy content varied from 1321.8 to 3086.9, crude protein content varied from 4.7 to 14.9 g/100g, crude fiber content varied from 6.4 to 41.5 g/100g, ether extract content varied from 1.0 to 18.0 g/100g, nitrogen free extract content varied from 25.1 to 52.9 g/100g and total ash content varied from 7.1 to 17.6.

CHAPTER – 3

MATERIAL AND METHODS

MATERIALS AND METHODS

The present investigations on Process standardization and quality evaluation of millet fortified papad were conducted in Department of Food Science & Technology, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidhyalaya, Jabalpur during the year 2012-13. The materials used and methods adopted for the purpose of investigation have been presented in this chapter.

3.1 Experimental materials

Kodo, kutki, rice, soybean and green gram grains were procured from College of Agriculture, Jabalpur (M.P.). Sago (Sabudana) were purchased from the local market. The packaging materials namely Low density polyethylene (LDPE), air tight plastic boxes and air tight steel container were purchased from the local market. The chemicals used in the present investigation were standard and analytical grade.

3.2 Preparation of papad

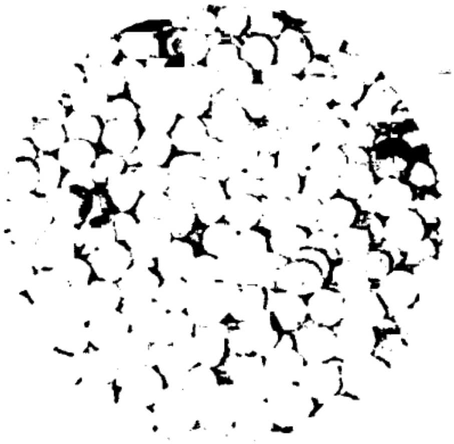
Grains of Kodo, kutki, rice, green gram, soybean and sago were taken as the materials for conducting various experiments in this investigation. The methods used for preparation of full fat soy flour from soybean, kodo flour from kodo, kutki flour from kutki, rice flour from rice and green gram flour from green gram have been given below.

3.2.1 Preparation of kodo flour

The clean, healthy and dehulled grains of kodo were taken for preparation of kodo flour. Kodo grains were finely grind in a electric grinder and passed through a 60 mesh size sieve. The powdered sample was stored in an air tight container until further use for various experiments.

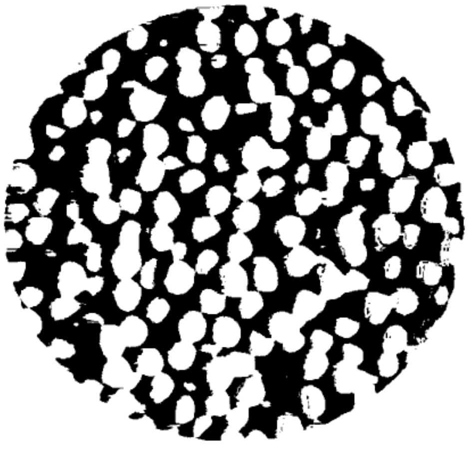
KODO GRAIN

KUTKI GRAIN

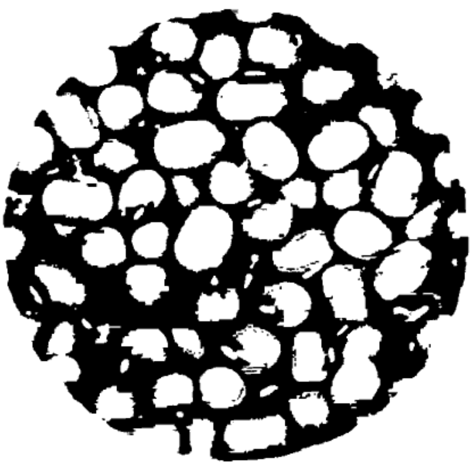


SAGO

RICE GRAIN



SOYBEAN GRAIN



GREEN GRAM GRAIN

Plate No 1 - Raw material used for formulation of minor millets papad.

3.2.2 Preparation of kutki flour

The clean, healthy and dehulled grains of kutki were taken for preparation of kutki flour. Kutki grains were finely grind in a electric grinder and passed through a 60 mesh size sieve. The powdered sample of KUF was stored in an air tight container until further use for various experiments.

3.2.3 Preparation of full fat soy flour

Soybean grains were thoroughly cleaned to remove the dirt, dust and other foreign materials. The clean grains were tempered with water to 20-25 per cent moisture content and then autoclaved for 15 minutes in a pressure cooker. They were removed and dried in the sun for 3-4 days and kept in oven for further drying till the moisture becomes constant. The grains were dehulled in electric operated chakki to remove the husk. Soybean was then ground to make fine flour and sieved through 80–100 mesh sieves. The flour was roasted in 5% vanaspati ghee till it became brown in colour. Roasting was done at 70-80 °C on a low flame to avoid burning of flour and then stored in airtight container before use.

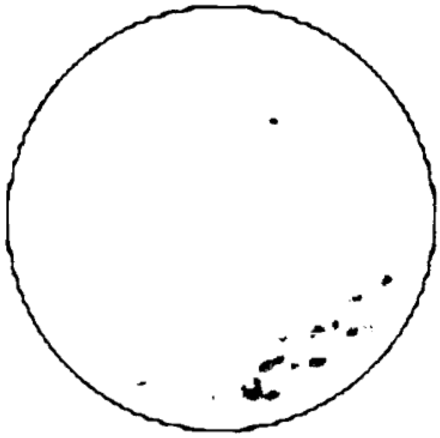
3.2.4 Preparation of green gram flour

The clean and healthy seeds of green gram were taken for preparations of green gram flour. The green gram dehulled in order to separate out hulls and dal. The split dhal were finely ground in a electric grinder and passed through a 60 mesh size sieve. The powdered sample of GGF was stored in an air tight container until further use for various studies.

KODO FLOUR

KUTKI FLOUR

RICE FLOUR



SOYBEAN FLOUR

GREEN GRAM FLOUR

Plate No - 2 - Different flour used for formulation of minor millets papad

3.2.6 Treatment combination

Table 1. Different combinations for preparation of minor millet based papad

Combinations	Kof	Kuf	Rf	Sf	Ggf	Ffs
Kodo based papad						
Ko_0	100	-	0	-	-	-
Ko_1	80	-	20	-	-	-
Ko_2	60	-	40	-	-	-
Ko_3	40	-	60	-	-	-
Ko_4	20	-	80	-	-	-
Ko_5	0	-	100	-	-	-
Ko_6	80	-	-	20	-	-
Ko_7	60	-	-	40	-	-
Ko_8	40	-	-	60	-	-
Ko_9	20	-	-	80	-	-
Ko_{10}	0	-	-	100	-	-
Ko_{11}	95	-	-	-	5	-
Ko_{12}	90	-	-	-	10	-
Ko_{13}	85	-	-	-	15	-
Ko_{14}	80	-	-	-	20	-
Ko_{15}	95	-	-	-	-	5
Ko_{16}	90	-	-	-	-	10
Ko_{17}	85	-	-	-	-	15
Ko_{18}	80	-	-	-	-	20
Kutki based papad						
Ku_0	-	100	0	-	-	-
Ku_1	-	80	20	-	-	-
Ku_2	-	60	40	-	-	-
Ku_3	-	40	60	-	-	-
Ku_4	-	20	80	-	-	-
Ku_5	-	0	100	-	-	-
Ku_6	-	80	-	20	-	-
Ku_7	-	60	-	40	-	-
Ku_8	-	40	-	60	-	-
Ku_9	-	20	-	80	-	-
Ku_{10}	-	0	-	100	-	-
Ku_{11}	-	95	-	-	5	-
Ku_{12}	-	90	-	-	10	-
Ku_{13}	-	85	-	-	15	-
Ku_{14}	-	80	-	-	20	-
Ku_{15}	-	95	-	-	-	5
Ku_{16}	-	90	-	-	-	10
Ku_{17}	-	85	-	-	-	15
Ku_{18}	-	80	-	-	-	20

Ko =Kodo flour, Kuf = Kutiki flour,
Rf= Rice flour, Sf= Sago flour,
Ggf = Green gram flour, Ffs = Full fat soya flour

Preparation of millet fortified papads

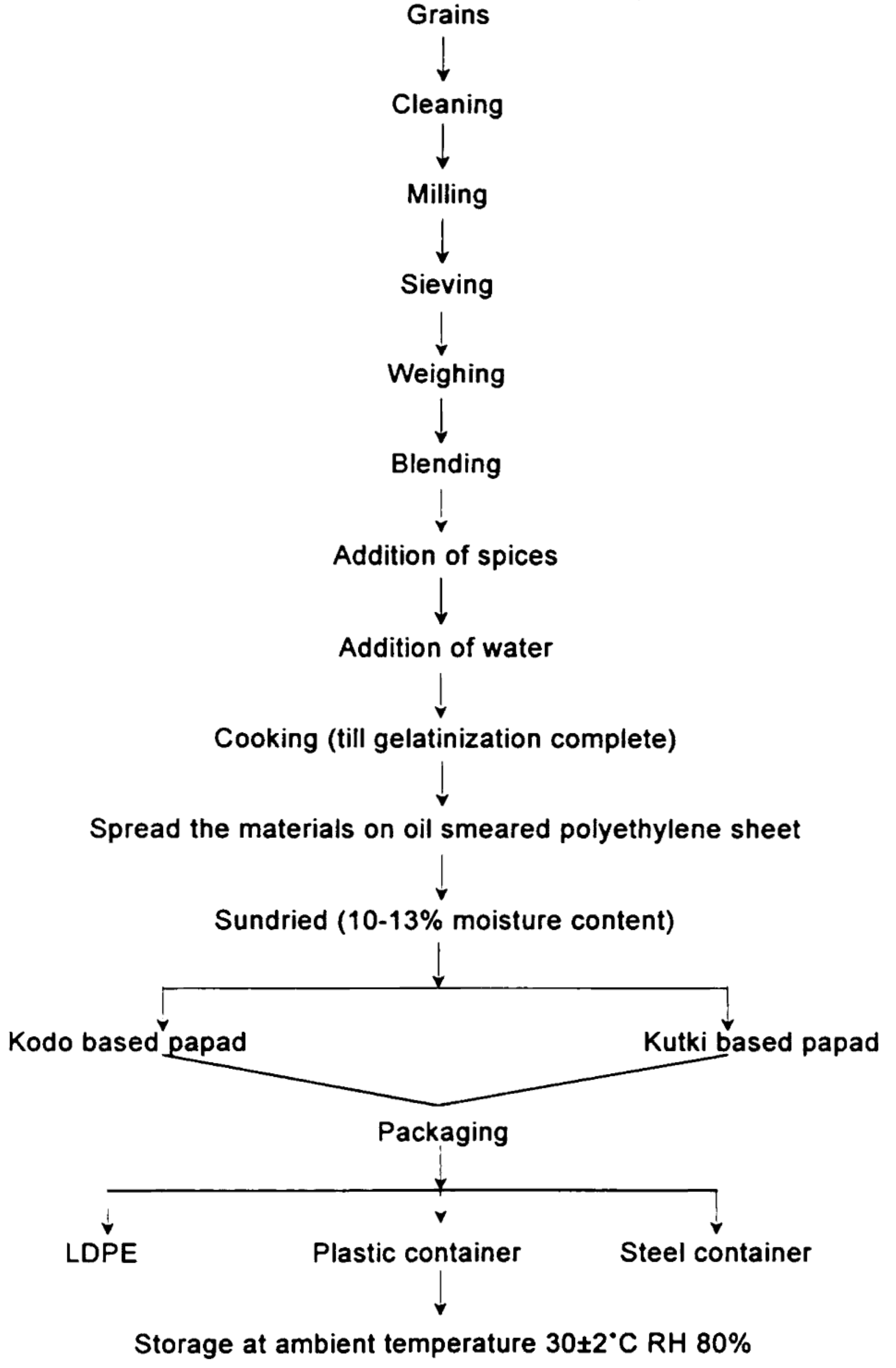


Figure 1. Flow chart for preparation of millet based fortified papad

3.2.5 Preparation of rice flour

The clean, healthy and dehulled grains of rice were taken for preparation of rice flour. Rice grains were finely grind in a electric grinder and passed through a 60 mesh size sieve. The powdered sample of RF was stored in an air tight container until further use for various experiments.

3.2.7 Standardization of processing parameters (ingredients) for preparation of papad

In the present investigation, attempts have been made for minor millet (kodo and kutki) based fortified papad making at different levels. Traditional method of papad making involves cooking the solution at desired consistency then thin circular discs spread out at smeared polythene sheet. Different ingredients like common salt, cumin seeds and papad khar will be added at cooking time. However, little is known about the role of these ingredients on the quality attributes like spreading, frying, overall acceptability and storage studies of papad.

3.3 Physical and functional properties of minor millet based papad

Various blends as mentioned earlier, prepared by incorporated with kodo and kutki flour, were evaluated for their functional properties. The method used for assessing the functional properties are discussed below:-

3.3.1 Percent expansion

The percent expansion of papads was calculated by using the following formula according to Surpalekar (1970).

$$\%\ \text{expansion} = \frac{\text{Diameter of fried papad} - \text{Diameter of raw papad} \times 100}{\text{Diameter of raw papad}}$$

3.3.2 Colour analysis

Colour was measured using Hunter colour lab analyzer where L, a and b values were recorded for the different papad combinations (Hunter, 1965). The opponent color scale give measurement of color in units of approximate visual infirmity throughout the color solid thus in the Hunter scale

"L" measure lightness and varies from 100 for perfect white to 0 for black, approximately as the eyes would evaluate it.

The chromaticity dimension (a and b) gives understandable designation s of color as follows:

"a" measures redness when positive, grey when 0 and green when negative.

"b" measures yellowness when positive, grey when 0 and blue when negative.

Procedure

The sensor of hunter lab was standardized with a white and black tile provide with the machine. The sample were taken for measurement of color using hunter lab color flex colorimeter color in terms of L, a, b scale. Sample color was measured by placing the sample in 10 mm aperture of sample measurement port of the colorimeter and the reading was observed.

3.3.3 Bulk density

Wang and Kinsella 1976. A 3.0 g sample of the finely powdered (60 mesh) sample was placed in a 25mL graduated cylinder and packed gently by tapping the cylinder on a rubber sheet until a constant volume was obtained. The procedure was repeated at least three times with different samples and the average value was taken. The bulk density was expressed as g ml^{-1} of sample.

$$\text{Bulk density (g ml}^{-1}\text{)} = \frac{\text{Weight of material (g)}}{\text{Volume of container (ml)}}$$

3.3.4 Water absorption capacity

WAC was determined by the method given by Sosulski *et al.* (1976). 1 gm of sample was put in a centrifuge tube to which 10 ml of water was added. The mixture was then allowed to stand for 10 minutes before centrifuge at 3500 rpm for 30 minutes. The water was the drained completely by inkling the tube at 45° angle and then measured. Initial and final volumes are given in percentage.

3.3.5 Fat absorption capacity

Fat absorption method was measured by following the method of Sosulski *et al.* (1976). 500mg sample was directly weight into 15ml of centrifuged tube. 10ml refined ground nut oil was added to it. The content was shaken for 30 min. and centrifuged at 3200 rpm for 25 min. The volume of free oil was then read. FAC was expressed as the amount (ml) of oil bound by 100g sample.

3.3.6 Emulsifying capacity

The method of Beuchat *et al.* (1975) was used for determination of emulsifying capacity. The dispersion was blended for 30 sec. at low speed for dispersing the material completely. After complete the dispersion refined ground nut oil was added to the dispersion from a burette and blended thoroughly. The addition of oil was continued until there was a phase separation. This was determined visually and recorded emulsifying capacity was expressed as ml of oil emulsified by one g of sample.

3.3.7 Foaming capacity

The method of Beuchat *et al.* (1975) was used for determination of foaming capacity. 5g of the sample was taken along with 100ml water in a bajaj electric blender. The suspension was stirred at 100xG for 5min and mixture was poured in to 250ml measuring cylinder and total volume was recorded after 30 sec. the foaming capacity was expressed in the term of percent foam volume increase.

3.4 Proximate analysis

Papads were prepared from various blend combination fortified by kodo flour 40, 60, 85 & 90 levels and kutki flour at 20, 40 & 90 levels with RF, SF, GGF, DSF. These sundried papads were powdered (30 mesh) and analysed for various chemical characteristics moisture content, crude protein, crude fat content, crude fibre, total ash, carbohydrates & minerals.

3.4.1 Moisture Content

The moisture content in different samples was estimated as per the procedure given below prescribed by A.O.AC. (1980).

Procedure

5 g of sample was accurately weighed in a preweighed moisture box, dried at 105°C for 8 hr. in hot air oven, cooled in a dessicator and weighed. The difference in weight of moisture box represented the moisture content of the sample.

Calculation

$$\text{Moisture \%} = \frac{\text{Difference in weight}}{\text{Weight of sample}} \times 100$$

3.4.2 Carbohydrates

Total carbohydrate in the samples was estimated by hydrolysis method as described in AOAC (1995). 2.5gm sample was taken in the flask and suspended in 200 ml of distilled water. 20ml of 3N HCl was added refluxed in an air condenser for 3hrs. On cooling, it was neutralized with alkali to pH 7.0, filtered and volume was made to 250 ml with distilled water.

The total carbohydrate in the filtrate was determined by titrating it with Fehling's solution (A & B) using 1 ml of methyl blue indicator. Factor was worked out by titrating 1% dextrose with Fehling's solution. In each titration Fehling's solution in the conical flask was heated with a constant flame and titration was done with filtrate in the burette until the end point (Brick- Red color) was obtained. The total carbohydrate content was calculated as follows:

$$\text{Factor} = \frac{\text{1g dextrose x dextrose titration value}}{100}$$

$$\text{Dextrose \%} = \frac{\text{Factor x 250}}{\text{Titrated value X weight of sample}} \times 100$$

Total carbohydrate (%) = Dextrose % x 0.9

3.4.3 Crude Protein

The protein content in sample was determined by using Kel-Plus digestion, distillation and titration method as given by AOAC (1995) 0.2g of sample was weighed accurately and transferred in DTL (digestion tubes large) taking care to see that the material did not stick to the neck of the tubes. The catalyst mixture Of 0.3g and concentrated sulphuric acid (10ml) were added. Then the tubes were placed in an inclined position in digestion chamber and heated till the liquid became clear (green blue color). The contents in the flasks were allowed to cool, diluted and then distilled using 40% sodium hydroxide and 4% boric acid. During distillation, ammonia was liberated from the samples and absorbed in the conical flask containing boric acid and 2-3 drops of mixed indicator changing the colour to light green. The distilled off ammonia was titrated against 0.1N sulphuric acid. The blank was also run in a similar way. Protein percentage was then calculated from the nitrogen percentage by multiplying with factor 6.25 as follows:

$$\text{Nitrogen\%} = \frac{14.01 \times 0.1 \times (TV\text{-}BV) \times 100}{\text{Sample weight} \times 1000}$$

Where,

TV = Titrated value

BV = Blank value

14.01 = Ammonia molecular weight

0.1 = Normality of Sulphuric acid for titration

$$\text{Crude protein (\%)} = \text{Nitrogen\%} \times 6.25$$

3.4.4 Ash

The ash content in the sample was estimated by burning the sample (5g) on gas burner until it was completely charred. The samples were then put in muffle furnace for combustion at 520°C for 5hrs and weighed after cooling. The heating in muffle furnace was repeated until constant weight was obtained (AOAC, 1995). Percentage ash was then calculated as follows:

$$\text{Ash (\%)} = \frac{\text{Initial weight} - \text{Final weight}}{\text{Weight of sample}} \times 100$$

3.4.5 Crude fat

Crude fat was extracted using petroleum ether (AR grade 60-80°c) using the SOC-PLUS, Pelican make as given by AOAC (1995). 5g of sample was weighed accurately, placed in thimble and plugged with cotton. The thimble was placed over a pre weighed soxlet beaker (A). The soxlet beakers were then fixed on the SOCS–PLUS equipment and 80ml petroleum ether added. The samples were then heated for one hour at 80°C, after which the temperature was raised to 160°C for another one hour. After extraction the thimbles were removed and excess solvent dried in Hot Air Oven at 200°c and final weight of beaker obtained. Fat was calculated as follows:

$$\text{Crude Fat \%} = \frac{(\text{Final weight of beaker} - \text{Initial weight of beaker})}{\text{Weight of sample}} \times 100$$

3.4.6 Crude fiber

The crude fibre was determined by the method as described in AOAC (1984).

Reagents

1. Sulphuric acid 0.255 N
2. Sodium hydroxide 0.313N

Procedure

2gm of dry defatted sample was transferred into 500ml conical flask to which 200ml of 0.255 N boiling sulphuric acid was added then it was boiled for 30 minutes, kept the volume constant by the addition of water at frequent intervals. The mixture was cooled and filtered through a muslin cloth and the residue was washed with hot water till free from acid. The material was then transferred to the same beaker and 200ml of boiling 0.313 N NaOH was added. After boiling for 30 minutes the mixture was cooled and again filtered through muslin cloth. The residue was washed with water till free from alkali, followed by washing with absolute alcohol and ether to remove the moisture and residue fat. It was then transferred to a weighed crucible and kept in oven at 100 °C for 4-6 hours. The crucible was cooled and weighed. The difference in weight represents the crude fibre content.

$$\text{Crude fibre (\%)} = \frac{\text{Difference in weight of crucible}}{\text{Weight of sample}} \times 100$$

3.4.7 Estimation of Minerals

Minerals content of papad were obtained by calculation using table values (Gopalan *et al.* 1996). In this case, percentage mineral content was calculated based on the mineral content of different ingredients used in the formulation of the Papad.

3.4.8 Energy Value

The total energy values were calculated by using values 4, 4, and 9 for protein, carbohydrate and fat respectively as follows:

Total energy (kcal/100g) = [(% available carbohydrates x4) + (% protein x4) + (% fat x9)]

3.4.9 Determination of Fatty acid (acidity)

Fatty acid acidity was determined as per the method of A.O.A.C (1984).

Reagents

1. 95%Ethanol
2. 1% Phenolphthalein indicator (1 g of indicator was dissolved in 100 ml 95% ethanol).
3. 0.1N Potassium hydroxide- 5.61 g of KOH was dissolved in 1000ml distilled water.

Procedure

10g sample was transferred into 250 ml volumetric flask in which 50 ml 95% ethanol was added. The solution was titrated against standard 0.1 KOH with constant shaking until end point (appearance of persistent pink colour). The value of fatty acid acidity in the sample was calculated the formulae:

Calculation

$$\text{Free fatty acid as oleic acid} = \frac{56.1 \times \text{ml of alkali} \times \text{normality of alkali}}{\text{Wt. of sample taken (g)}}$$

3.5 Sensory quality characteristics of "papad" prepared from fortified blends

All the combination of papad were fried, organoleptic properties of fried papad were evaluated by the panel of 10 judges based on the sensory attributes of colour, appearance, taste, flavor, mouth feel and overall acceptability. The evaluation was done on a nine point of hedonic scale as described by Amerine *et al.* (1965).

Sensory evaluation score card

Give the rating of the food products provided on the sensory attributes based on the following ratings:

1. Like extremely 9
2. Like very much 8
3. Like moderately 7
4. Like slightly 6
5. Neither like nor dislike 5
6. Dislike slightly 4
7. Dislike moderately 3
8. Dislike very much 2
9. Dislike extremely 1

Sensory Attributes	Code 1	Code 2	Code 3	Code 4	Code 5
Colour & Appearance					
Aroma					
Taste					
Texture					
Overall acceptability					

Comments

3.6 Storage studies

The shelf life studies of millets based papads were carried out in LDPE, plastic containers and steel containers for a period of 6 months at ambient temperature 30±2°C RH 80%. 100 g of each sample were packed and kept at room temperature. All samples were drawn periodically after 30 days and analyzed moisture, expansion ratio, fatty acid acidity, peroxide value and sensory attributes according to standard procedures as described earlier in the chapter.

3.7 Statistical methodology

The results/data of the analysis for different parameters were analyzed statistically to assess the degree of variation within the treatments as compared to the control. The data were subject to analysis of variance (ANOVA) and least significance difference to determine the difference between means, analyzed by Genstat computer package using Completely Randomized Design (CRD) at 5% level of significant.

The skeleton of analysis of variance

S. No	Source of variance	d.f.	SS	MSS	F calculated	F table value (5%)
1.	Treatments	(t-1)		TSS	TMS	TMS/EMS
2.	Error	(n-t)		ESS	EMS	
	Total	(n-1)				

Where,

t = Number of treatments

n = Number of observations

d.f. = Degree of freedom

T.S.S. = Treatment sum of square

E.S.S. = Error sum of square

T.M.S. = treatment mean sum of square

E.M.S. = Error mean sum of square

$$C.V. = \sqrt{\frac{EMS}{GM}} \times 100$$

$$SE(d) = \sqrt{\frac{2EMS}{r}}$$

C.D. = $t_{(0.05)}$ x SE(d)

Where,

C.V. = Coefficient of variation

S.E.(d) = Standard error of difference

G.M. = Grand mean

C.D. = Critical difference

$t_{(0.05)}$ = t-value at 5% probability level

CHAPTER – 4

RESULTS

RESULTS

The present investigations were carried out in the Department of Food science and Technology for the Process Standardization and Quality Evaluation of Millet Fortified Papad. The results obtained during the course of investigation have been described in this chapter in the form of tables and figures.

4.1 Sensory analysis of millet based papad

Different types of blend papad were developed from cereals, minor millet and pulses flour and subjected to sensory test on 9 point hedonic scale. From the sensory mean scores and the comments of the panelists, best combinations were selected (Kodo + Rice), (Kodo + Sago), (Kodo + Green gram), (Kodo + Soybean), (Kutki + Rice), (Kutki + Sago), (Kutki + Green gram) and (Kutki + Soybean) at the ratio of 40:60, 60:40, 90:10, 90:10, 20:80, 40:60, 85:15 and 90:10 respectively.

4.1.1 Sensory analysis of rice fortified papad based on kodo

The results of sensory analysis of papad made from kodo and rice flour in the different ratios are given in Table 2.

Table 2. Sensory attributes of rice fortified papad

Treatments	Appearance & colour	Aroma	Texture	Taste	Overall acceptability
KR_0	6.5	7.0	**6.0**	6.5	6.5
KR_1	**6.0**	**6.0**	**6.0**	**6.0**	**6.0**
KR_2	7.5	**6.0**	8.0	7.0	7.2
KR_3	**8.5**	**8.0**	**9.0**	8.0	**8.4**
KR_4	8.0	7.5	8.0	**8.0**	7.9
KR_5	7.0	**6.0**	6.5	7.0	6.7

KR_0 = Kodo control (100:0) KR_1 = Kodo + Rice (80:20)
KR_2 = Kodo + Rice (60:40) KR_3= Kodo + Rice (40:60)
KR_4= Kodo + Rice (20:80) KR_5= Kodo + Rice (0:100)

Appearance and colour

Maximum colour and appearance score (8.5) was found in KR_3 (Kodo+Rice) at the ratio of 60:40 whereas minimum (6.0) was found in KR_1 (Kodo+Rice) at the ratio 80:20. The data revealed that increased the ratio of kodo flour from decreased the mean scores for colour and appearance of rice fortified kodo papad. KR_2 and KR_4 rice fortified kodo papad were statistically at par with each other.

Aroma

The mean scores for flavour of the papad was statistically at par for KR_2, KR_4 and KR_5 respectively. The KR_1 combination was found to be scored lowest (6.00) while the highest score (8.00) was obtained in KR_4. However the KR_3 combination is followed by KR_4, KR_0, KR_2 and KR_5 rated 7.50, 7.00, 6.00 and 6.00respectively.

Texture

An appraisal of Table 2 showed that, the treatment KR_3 got the highest value 9.00 against control at 6.00. However, it increased on blending with rice and the treatment KR_1 got the lower value (6.00), while KR_2 and KR_4 obtained same value 8.00. KR_3 followed by KR_2, KR_4, KR_5, KR_0 and KR_1 rated 9.00, 8.00, 8.00, 6.50, 6.00 and 6.00 respectively. KR_2 , KR_4, KR_0 and KR_1 fortified papad were statistically at par with each other.

Taste

The data depicts in Table 2 revealed that, the mean scores for taste ranged from 6.00 to 8.00, while KR_3, KR_4, KR_2 and KR_5 obtained same table value 7.00, which were statistically at par with each other. The mean scores for taste of kodo based papad were above the acceptable limit with the lowest score (6.00) obtained from KR_1 kodo based papad against the highest score (8.00) in KR_4 kodo based papad.

KR 3

KS 2

KG 3

KSO2

Plate No 3 - Kodo based fortified papad.

Fortification of rice increased the mean scores for taste of rice fortified kodo papad.

Overall acceptability

All the papad were acceptable and combination KR_3 (kodo 40%+rice60%) was superior than others with the highest value at 8.40. Control papad with the treatments KR_4, KR_2, KR_5 were most accepted with scores 7.90, 7.20 and 6.70 respectively. Treatment KR_1 scored lowest value at 6.00. KR_0 were statistically at par with the scores 6.50 (control). The data showed that increased the blend ratio of rice in millet based papad increased the overall acceptability of papad.

4.1.2 Sensory analysis of sago fortified kodo papad

The results of sensory analysis of papad made from kodo and sago, in the different ratios are given in Table 3.

Table 3. Sensory analysis of sago fortified kodo papad

Treatments	Appearance & colour	Aroma	Texture	Taste	Overall acceptability
KS_0	6.9	6.4	6.3	**6.0**	6.4
KS_1	**6.0**	7.0	7.2	6.4	6.7
KS_2	**7.4**	**7.6**	**7.5**	**8.0**	**7.7**
KS_3	6.0	5.9	6.8	7.5	6.6
KS_4	7.0	7.0	**6.0**	**6.0**	6.5
KS_5	**6.0**	**6.0**	6.0	**6.0**	**6.0**

KS_0 = Kodo control (100:0) KS_1 = Kodo + Sago (80:20)
KS_2 = Kodo + Sago (60:40) KS_3= Kodo + Sago (40:60)
KS_4= Kodo + Sago (20:80) KS_5= Kodo + Sago (0:100)

The mean scores for colour and appearance of different combination and control ranged from 6.0 to 7.4. However the treatment KS_5, KS_3 and KS_1 got the lowest value at 6.00 while KS_2 got highest value at 7.4 which are higher than control at 6.90. The data showed that

60% Kodo+40% sago increased the colour mean score of products. KS_1, KS_3 and KS_5 papad were statistically at par with each other.

The aroma mean scores for fortified papad ranged from 5.90 to 7.60. Fortified papad KS_1 and KS_4 had got same value at 7.00. However the treatment KS_3 got the lowest value 5.9 while KS_2 got highest value at 7.60. Sago fortified kodo papad Ks_0 and KS_5 were found to contain aroma mean scores at 6.40 and 6.00 respectively. Data revealed that the sago (40-60%) increased the aroma of the fortified papad.

KS_4 and KS_5 fortified papad gave the same and lowest texture mean score at 6.00, while the highest value is KS_2 7.5 followed by KS_1, KS_3 and KS_0 had average mean 7.2, 6.8 and 6.3 respectively. From the table we observed that supplementation decrease the texture of fortified papad.

An appraisal of table 3 showed that, the treatment KS_2 got highest taste mean score 8.00 against the lowest value 6.00 for KS_4, KS_5 and control at 6.00. Data showed that 60% kodo and 40% sago were helpful to increase the taste of fortified papad. Increased the fortification of sago decreased the taste of papad.

All the papad were acceptable with kodo fortified sago papad KS_2 gave the highest score of 7.70 and KS_5 gave the lowest score at 6.00. The mean scores obtained by sago fortified kodo papad were 6.7, 6.6, 6.5 and 6.4 from KS_0 to KS_5 respectively. 60% flour of kodo and 40% sago increased the acceptability of sago fortified kodo based papad.

4.1.3 Sensory analysis of green gram fortified kodo papad

The results of sensory analysis of papad made from kodo and green gram in the different ratios are given in the table 4.

Table 4. Sensory attributes of green gram fortified kodo papad

Treatments	Appearance & colour	Aroma	Texture	Taste	Overall acceptability
KG_0	**6.0**	**6.0**	7.0	**6.0**	**6.3**
KG_1	6.5	6.4	6.5	6.8	6.6
KG_2	7.0	7.0	**6.0**	**6.0**	6.5
KG_3	**7.5**	**7.4**	**8.0**	**7.5**	**7.6**
KG_4	6.9	6.8	6.5	7.0	6.8

KG_0 = Kodo control (100:0) KG_1 = Kodo + Green gram (95:5)
KG_2 = Kodo + Green gram (90:10) KG_3= Kodo + Green gram (85:15)
KG_4= Kodo + Green gram (80:20)

It was observed from the Table 4 the maximum mean score for colour and appearance obtained from KG_3 at 7.50. However the treatment KG_0 got the lowest value at 6.00. Mean scores of fortified papad were 6.50, 6.90 and 7.00 from KG_1, KG_2 and KG_4 respectively. The values for papad KG_2 and KG_4 were statistically at par with each other. Supplementation of 15% green gram + 85% kodo flour increased the colour mean score of papad.

The aroma means score for fortified papad ranged from 6.00 to 7.40 against controls papad at 6.00. Kodo fortified green gram papad was found to contain aroma mean scores 6.00, 6.40, 7.00, 7.40 and 6.90 from KG_0 to KG_4 respectively. Treatments KG_3 gave the highest value, while KG_0 gave lowest value at. Fortified papad KG_2 and KG_4 were statistically at par with each other.

It is evident from the results for texture mean scores for the treatments KG_0 and KG_1 were statistically at par with each other. The treatment KG_2 got the lowest value (6.00) while KG_3 scored the highest value (8.00). KG_3 and KG_1 followed by KG_4 and KG_2 (7.00), (6.5), (6.5) and (6.0) respectively. The table showed that 15% of green gram had good texture mean score for fortified papad.

Process Standardization and Quality Evaluation of Millet Fortified Papad

THESIS

Submitted to the

Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur

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In

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(FOOD TECHNOLOGY)

By

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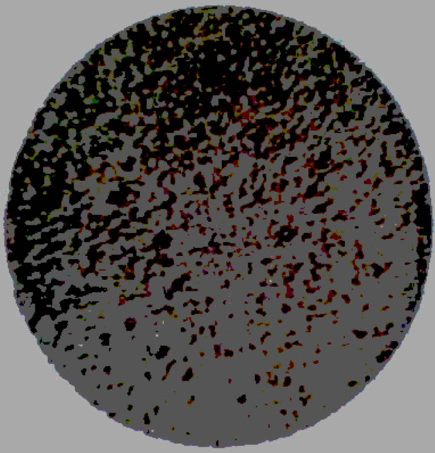
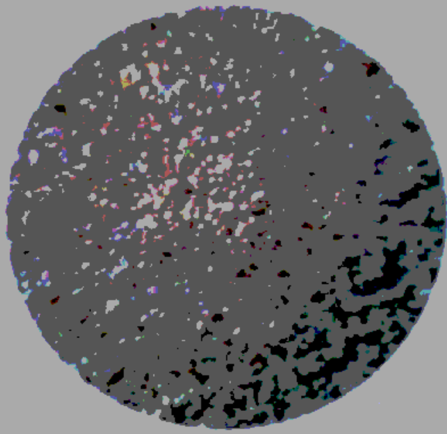
College of Agriculture, Jabalpur (M.P.)

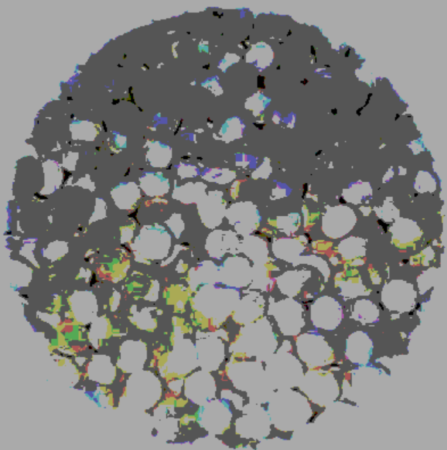
2013



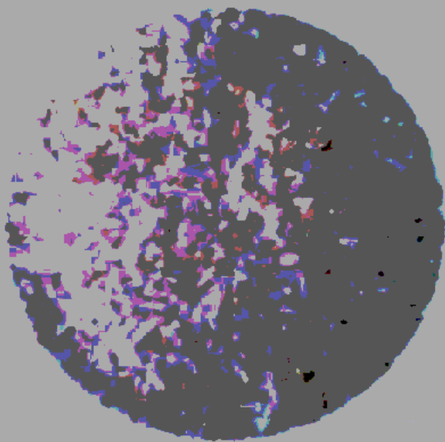
KODO GRAIN



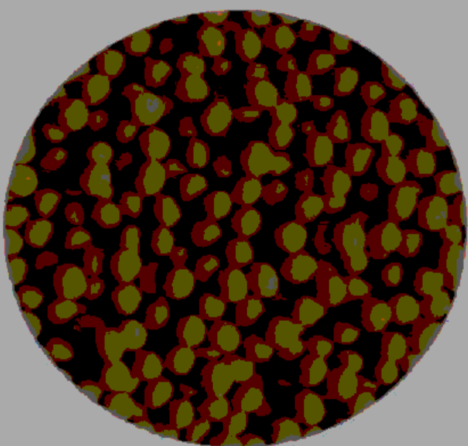
KUTKI GRAIN



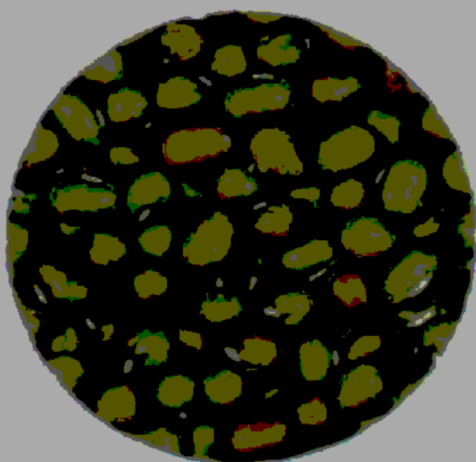
SAGO



RICE GRAIN

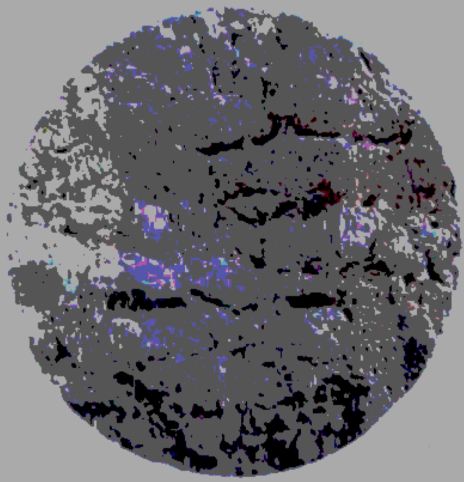


SOYBEAN GRAIN

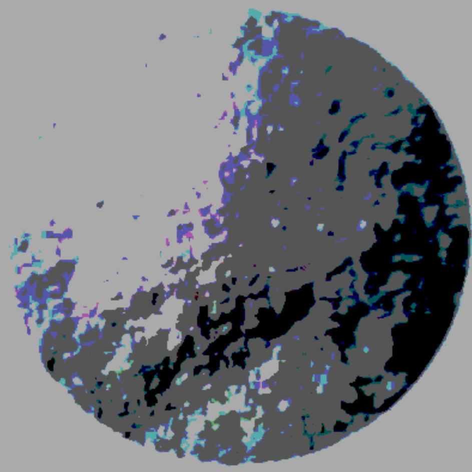


GREEN GRAM GRAIN

Plate No 1 - Raw material used for formulation of minor millets papad.



KODO FLOUR



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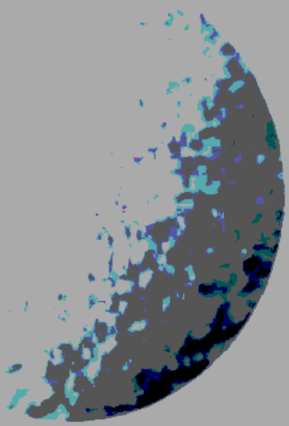
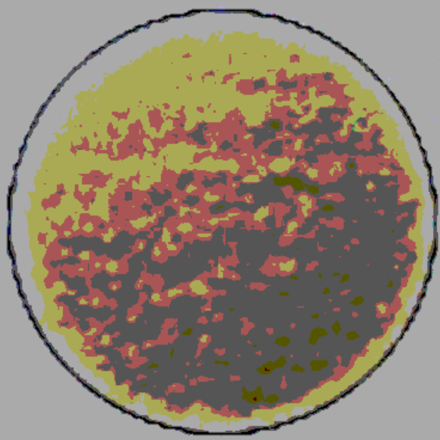
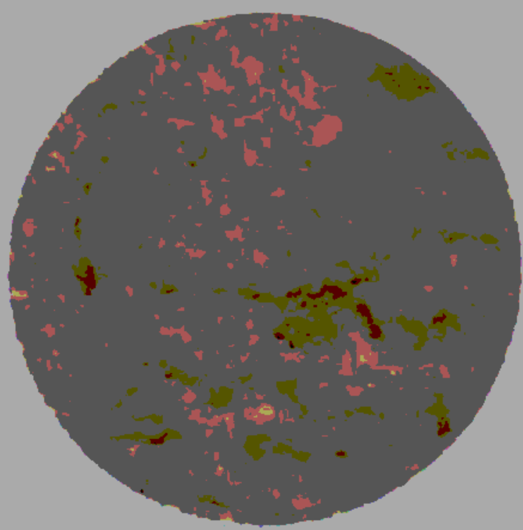


RICE FLOUR



SOYBEAN FLOUR



GREEN GRAM FLOUR

Plate No - 2 - Different flour used for formulation of minor millets papad

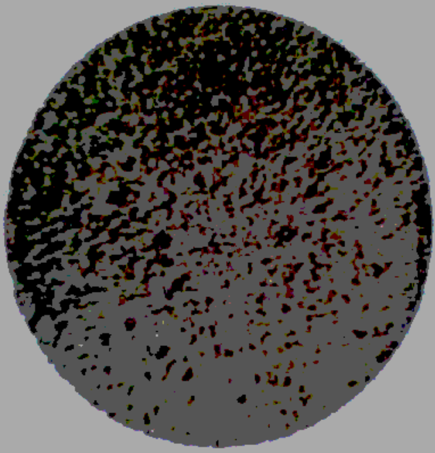
KuR_4

KuS_3

KuG_2

$KuSO_2$

Plate No 4 - Kutki based fortified papad .



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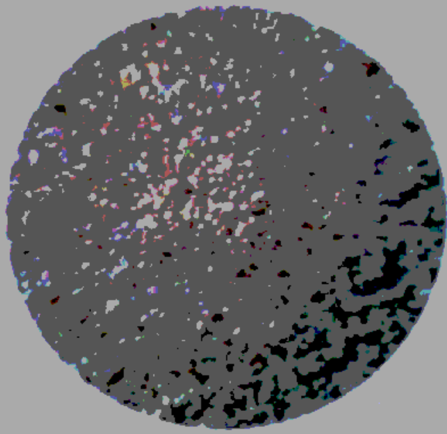
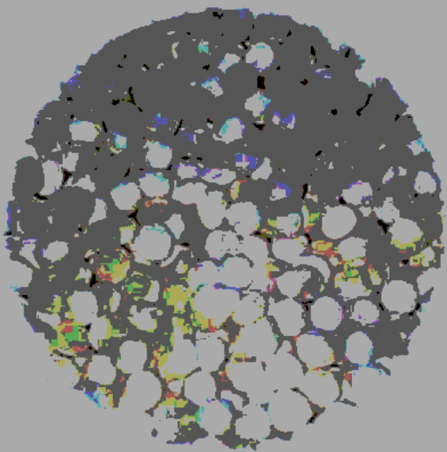
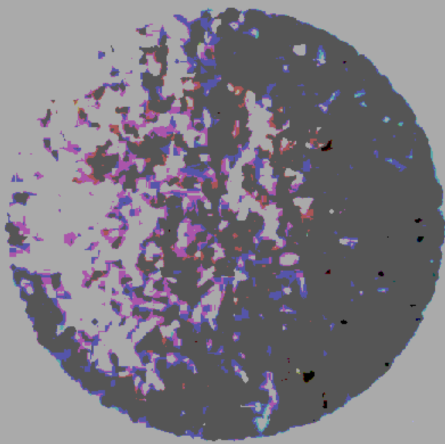


KUTKI GRAIN



SAGO



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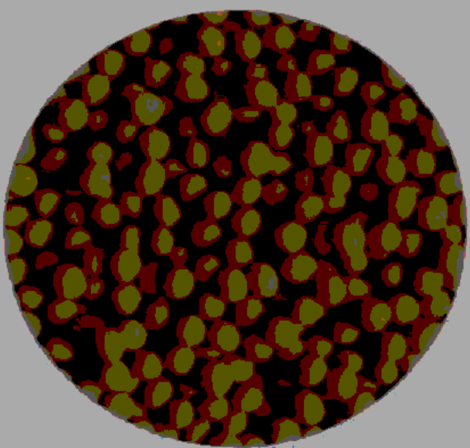
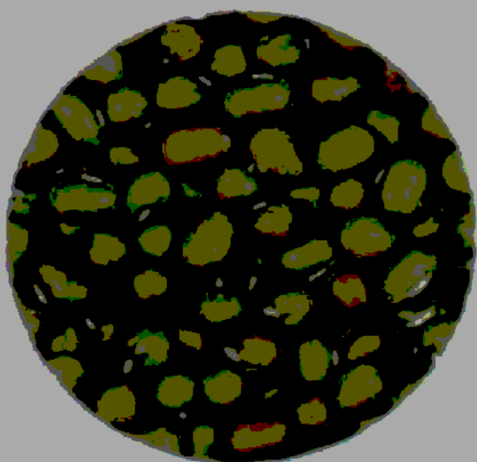
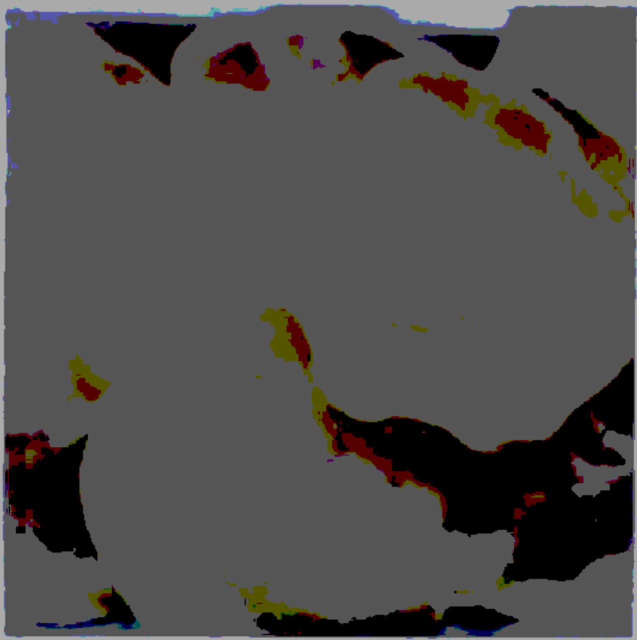


SOYBEAN GRAIN

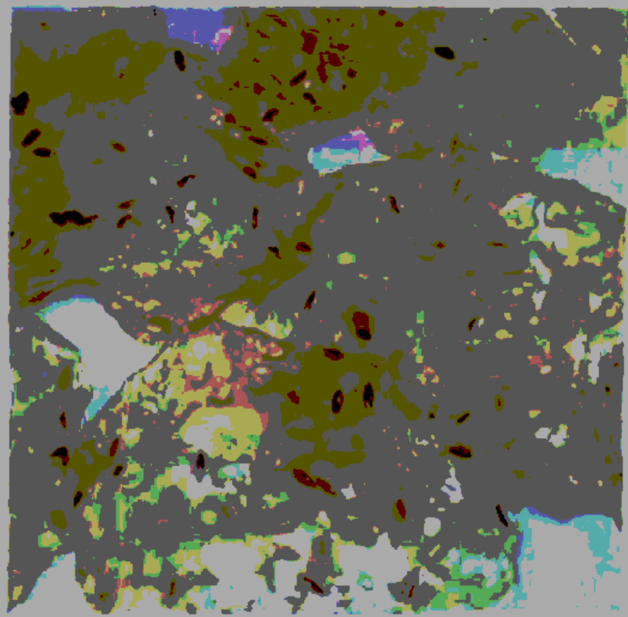


GREEN GRAM GRAIN

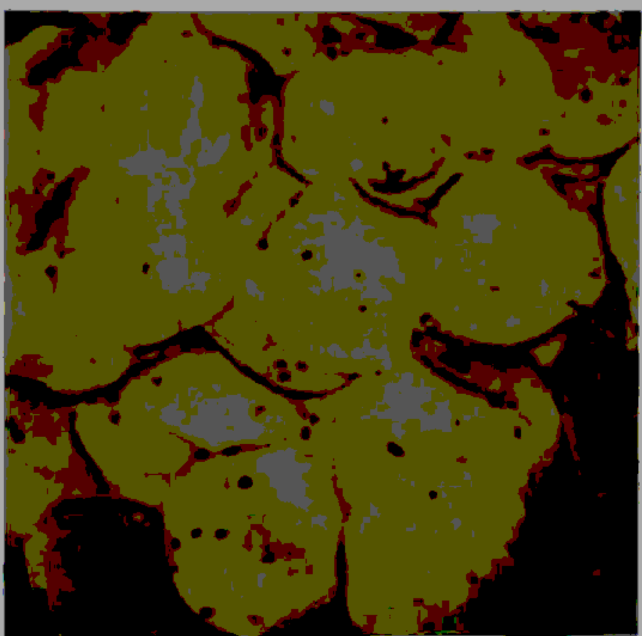
Plate No 1 - Raw material used for formulation of minor millets papad.



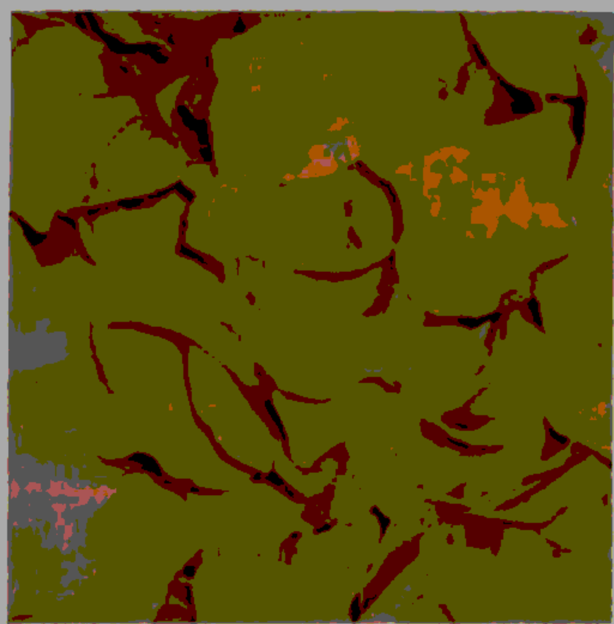
KuR_4



KuS_3



KuG_2



$KuSO_2$

Plate No 4 - Kutki based fortified papad .

4.1.7 Sensory analysis of green gram fortified kutki papad

The results of sensory analysis of papad made from kutki and green gram flour in the different ratios are given in Table 8.

Table 8. Sensory attributes of green gram fortified kutki papad

Treatments	Appearance & colour	Aroma	Texture	Taste	Overall acceptability
KuG_0	7.0	7.1	**6.0**	**6.2**	6.6
KuG_1	7.0	6.9	6.5	7.0	6.9
KuG_2	**7.5**	**7.2**	**7.9**	**8.0**	**7.7**
KuG_3	7.3	7.0	6.9	6.5	7.0
KuG_4	**6.0**	**6.0**	6.2	6.8	**6.3**

KuG_0 = Kodo control (100:0) KuG_1 = Kodo + Green gram (95:5)
KuG_2 = Kodo + Green gram (90:10) KuG_3= Kodo + Green gram (85:15)
KuG_4= Kodo + Green gram (80:20)

The data depicted in table 8 revealed that the maximum colour and appearance score (7.5) was found in KuG_2 (Kutki+green gram) at the ratio of 90:10 whereas minimum (6.0) was found in KuG_4 (Kutki+green gram) at the ratio 80:20. The data revealed that increased the ratio of green gram flour from decreased the mean scores for colour and appearance of green gram fortified kutki papad. KuG_1 and KuG_3 papad were statistically at par with each other.

The mean scores for flavour of the papad was statistically at par for KuG_0, KuG_2 and KuG_3 at 7.10 and 7.00 respectively. The KuG_4 combination was found to be scored lowest (6.00) while the highest score (7.20) was obtained in KuG_2. However the KuG_2 combination is followed by KuG_0, KuG_3 and KuG_1 rated 7.1, 7.0 and 6.90respectively.

An appraisal of table 8 showed that, the treatment KuG_2 got the highest texture value 7.9 against control at 6.00, whereas, texture of treatment KuG_0 got the lower value (6.00). KuG_2 followed by KuG_1, KuG_2 and KuG_4 rated 6.9, 6.5 and 6.2 respectively. KuG_0 and KuG_4 were statistically at par with each other.

The data depicts in Table 8 revealed that, the mean scores for taste ranged from 6.20 to 8.00. The mean scores for taste of green gram fortified papad were above the acceptable limit with the lowest score (6.20) obtained from KuG_0 green gram fortified papad against the highest score (8.00) in KuG_2 green gram fortified papad. The green gram fortified papad had got means score value 6.90 was at par with KuG_1 (7.00). Fortification of green gram increased the mean scores for taste of green gram fortified kutki papad.

All the papad were acceptable and combination KuG_2 (kutki 90%+green gram 10%) was superior than others with the highest value at 7.70. Control papad with the treatments KuG_1 and KuG_3 were most accepted with scores 6.6, 6.9 and 7.0 respectively. Treatment KuG_4 scored lowest value at 6.30. KuG_3 were statistically at par with the scores 7.00. Increased the ratio of green gram in papad increased the acceptability score upto 10% limit.

4.1.8 Sensory analysis of soybean fortified kutki papad

The results of sensory analysis of papad made from kutki and soybean in the different ratios are given in Table 9.

Table 9. Sensory analysis of kutki fortified soybean papad

Treatments	Appearance & colour	Aroma	Texture	Taste	Overall acceptability
$KuSO_0$	**7.5**	7.5	7.4	7.5	7.3
$KuSO_1$	7.3	7.0	7.2	7.1	7.2
$KuSO_2$	7.4	**7.9**	**8.0**	**8.3**	**7.9**
$KuSO_3$	6.5	6.9	7.0	7.2	6.9
$KuSO_4$	**6.0**	**6.0**	**6.9**	**6.5**	**6.4**

$KuSO_0$ = Kutki control (100:0) $KuSO_1$ = Kutki + Soybean (95:5)
$KuSO_2$ = Kutki + Soybean (90:10) $KuSO_3$= Kutki + Soybean (85:15)
$KuSO_4$= Kutki + Soybean (80:20)

The mean scores for colour and appearance of different combination and control ranged from 6.0 to 7.5. However the treatment

$KuSO_4$ got the lowest value at 6.00 while control treatment $KuSO_0$ got highest value at 7.5 than followed by $KuSO_3$, $KuSO_1$ at 7.40 and 7.3 respectively. The data showed that 90% Kutki+10% soybean increased the colour mean score of products. Increased the ratio of soybean decreased the colour of fortified papad.

The aroma mean scores for fortified papad ranged from 6.0 to 7.90. However the treatment $KuSO_4$ got the lowest value 6.0 while $KuSO_2$ got highest value at 7.90. Soybean fortified kutki papad $KuSO_0$ and $KuSO_1$ were found to contain aroma mean scores at 7.50 and 7.00 respectively. Data revealed that the soybean (90-10%) increased the aroma of the fortified papad.

$KuSO_4$ fortified papad gave the lowest texture mean score at 6.90, while the highest value is $KuSO_2$ 8.0 followed by $KuSO_0$, $KuSO_1$ and $KuSO_3$ had average mean 7.4, 7.2 and 7.0 respectively. From the table we observed that supplementation of soybean decreased the texture of fortified papad.

An appraisal of Table 9 showed that, the treatment $KuSO_2$ got highest taste mean score 8.30 against the lowest value 6.50 for $KuSO_4$. Treatment had average values at 7.5, 7.1, 8.3, 7.2and 6.5 from $KuSO_0$ to $KuSO_4$. Data showed that 90% kutki and 10% soybean were helpful to increased the taste of fortified papad. After that we found decreased trend for taste score.

All the papad were acceptable with soybean fortified papad $KuSO_3$ gave the highest score of 7.90 and $KuSO_5$ gave the lowest score at 6.40. The mean scores obtained by kutki fortified soybean papad were 7.3, 7.2, 7.9, 6.9 and 6.4 from $KuSO_0$ to $KuSO_4$ respectively. 90% flour of kutki and 10% soybean increased the acceptability of fortified papad.

4.2 Physical attributes of minor millet based papad

The results of the physical characteristics of minor millet fortified papad i.e. bulk density, colour analysis and expansion ratio compared to control are given in Table 10 and also comparisons are shown by the figure.

Physical characteristics of minor millet based papad

The results of physical attributes of millet based papad are given in Table 10 and graphically depicted through Figure 2.

Table 10. Physical attributes of minor millet based papad

S. No.	Treatments	Combination	Bulk density (g/ml) (Flour)	Bulk density (g/ml) (papad)	Expansion ratio (%)
Kodo based papad	KR_3	40 : 60	0.60	**0.66**	3.81
	KS_2	60 : 40	**0.66**	0.64	**4.57**
	KG_3	85 : 15	0.64	**0.58**	4.17
	KSO_2	90 : 10	0.60	**0.58**	4.56
	SEm±	-	0.0372	0.0372	0.107
	CD at 5%	-	0.107	0.107	0.0309
Kutki based papad	KuR_4	20 : 80	0.64	0.60	3.45
	KuS_3	40 : 60	0.62	0.64	4.11
	KuG_2	90 : 10	**0.58**	0.64	3.31
	$KuSO_2$	90 : 10	0.62	**0.66**	**3.22**
	SEm±	-	0.0372	0.0372	0.0143
	CD at 5%	-	0.107	0.107	0.0413

Bulk density (flour)

The bulk density of minor millet based flour ranged from 0.58 to 0.66 g/ml. Kodo+sago (KS_2) scoring highest value at 0.66 followed by

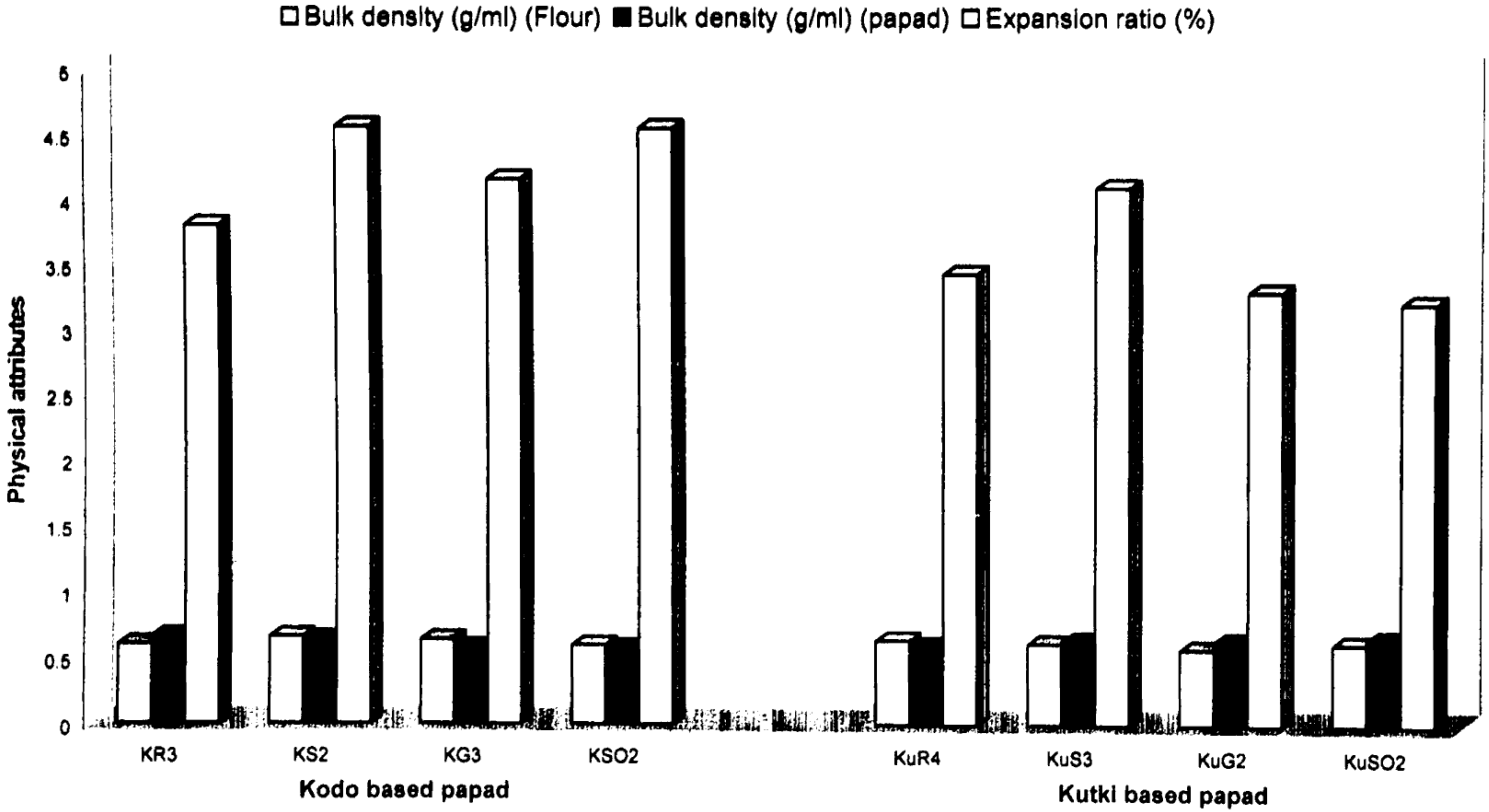


Figure 2. Physical attributes of Kodo and Kutki based papad

KG_3 (0.64), KuR_4 (0.64), KuS_3 (0.62), $KuSO_2$ (0.62), KR_3 (0.60) and KSO_2 (0.60). It is evident from the results that bulk density was decreased with fortification of rice, sago, green gram and soybean flour. Treatments KG_3, KR_3, KSO_2 and KuR_4 were at par value. There were a significant differences was found between the kodo and kutki based flour. In case of kodo based flour KG_3 (85:15) was significantly superior than other kodo based flour whereas kutki based flour KuR_4 (20:80) was significantly superior than other kutki based flour.

Bulk density (Papad)

As evident from the table 10 minor millet based papad were found to contain bulk density 0.66, 0.64, 0.58, 0.58, 0.60, 0.64, 0.64, 0.66 for KR_3, KS_2, KG_3, KSO_2, KuR_4, KuS_3, KuG_2 and $KuSO_2$ respectively. The highest value was recorded at 0.66 in KR_3 and $KuSO_2$ fortified papad, which was significantly superior than others whereas minimum bulk density was recorded in KG_3 and KSO_2 (0.58). It is evident from the results that the bulk density was reduced as blending with different ratio of pulses flour. Treatments KS_2, KuS_3 and KuG_2 were at par with each other.

Expansion ratio

As evident from table 10 the expansion ratio analyzed for minor millet based papad showed a positive trend and it is greatly increased with the addition of pulses (soybean and green gram) and sago. KS_2 got the highest value at 4.57 %. Treatments KR_3, KS_2, KG_3, KSO_2, KuR_4, KuS_2, KuG_2 and $KuSO_2$ scored 3.81, 4.57, 4.16, 4.56, 3.45, 4.11, 3.31 and 3.22 % respectively. KS_2, KSO_2, KuS_2 and KuR_4 were at par with each other. Supplementation of soybean and sago were increased the expansion ratio of minor millet based papad. Sago fortified kodo and kutki based papad were significantly superior than other papad.

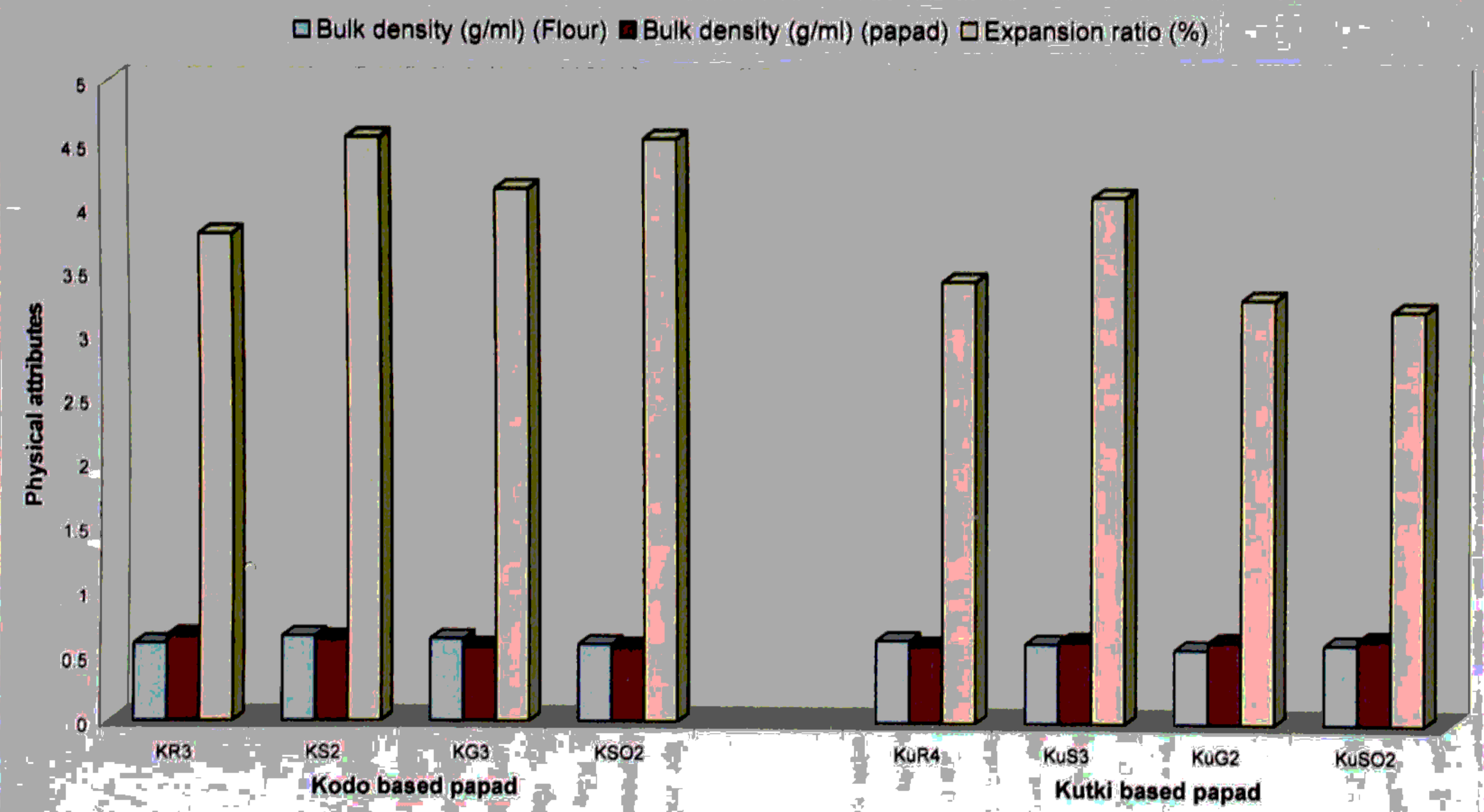


Figure 2. Physical attributes of Kodo and Kutki based papad

Table 11. Functional attributes of minor millet based papad

S.No.	Treatments	Combination	Water absorption capacity (ml/100g)	Fat absorption capacity (ml/100g)	Emulsifying capacity (ml/g flour)	Foaming capacity (foam increase %)
Kodo based papad	KR_3	40 : 60	160	**100**	**21**	90
	KS_2	60 : 40	160	120	22.5	98
	KG_3	85 : 15	180	120	23	106
	KSO_2	90 : 10	200	180	**24**	81
	SEm±	-	NS	2.33	0.724	1.26
	CD at 5%	-	-	6.74	2.092	3.66
Kutki based papad	KuR_4	20 : 80	**140**	140	21.5	**74**
	KuS_3	40 : 60	120	160	22	78
	KuG_2	90 : 10	120	**200**	23	108
	$KuSO_2$	90 : 10	**220**	**200**	**24**	**112**
	SEm±	-	4.49	5.09	0.53	0.40
	CD at 5%	-	14.49	14.72	1.55	1.16

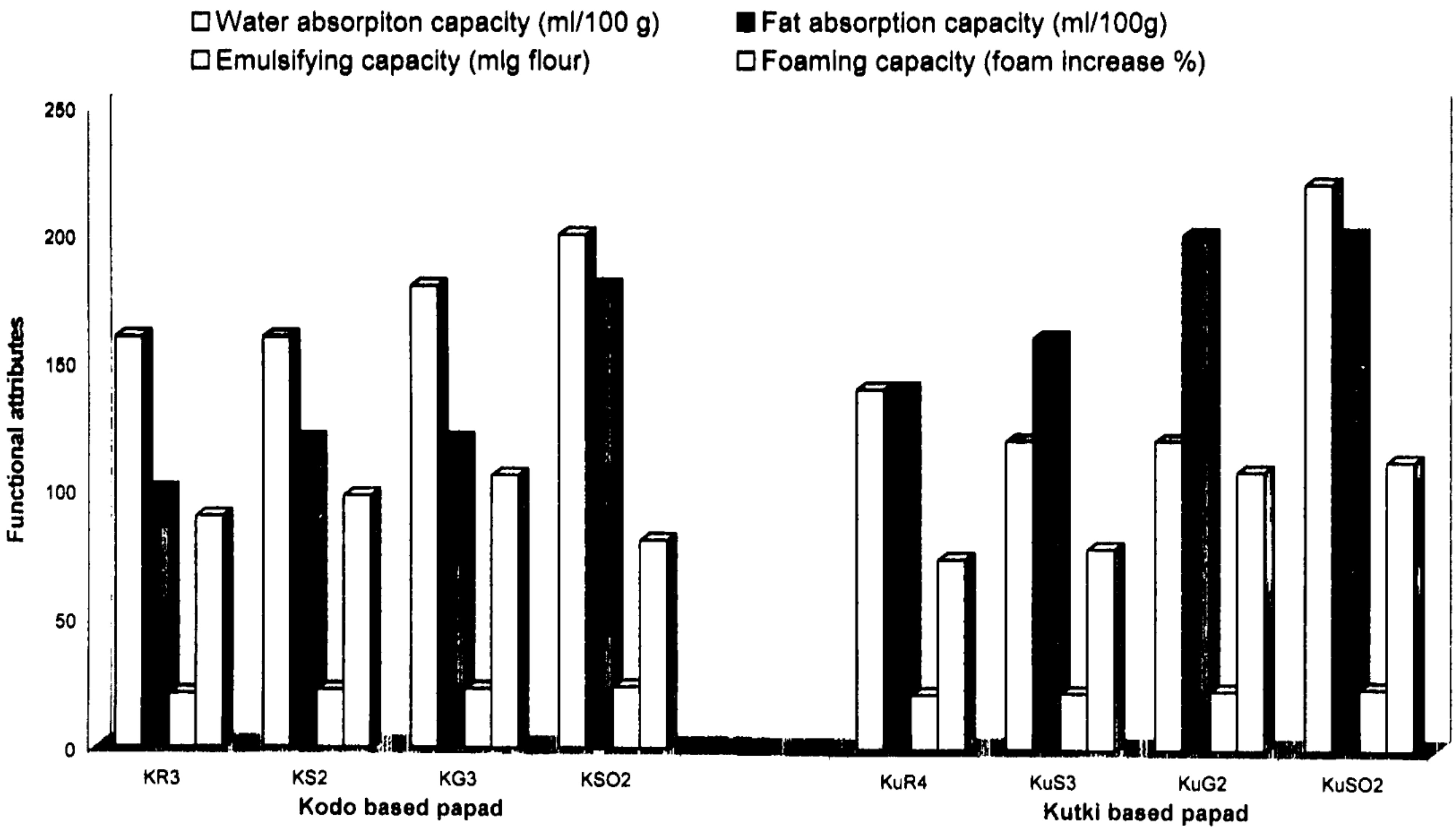


Figure 3. Functional attributes of kodo and kutki based papad

Emulsifying capacity

It is clear from the data presented in table 11 that the emulsifying capacity values of blend made of minor millet based flour. The observations recorded that with the relative incorporation of soya flour in minor millet based blends, there was a proportionate increase in the emulsifying capacity values of the fortified blends. It was seen that the substitution of minor millet by rice, sago, green gram and soybean, the emulsifying capacity values were recorded respectively as 21, 21.5, 22, 22.5, 23 and 24 ml/g. Maximum emulsifying capacity was record in KSO_3 and $KuSO_2$ (24 ml/g) whereas minimum was recorded in rice fortified minor millet based papad (21 ml/g). The table showed that the fortification of soy flour in both millet significantly superior than fortified papad in both millet based papad. All fortified minor millet papad were statistically at par with each other.

Foaming capacity

As can be seen from the data presented in table 11 that the blend made up of soybean fortified kutki papad (90:10) recorded the foaming capacity value of 112% whereas minimum was found in higher KuR4 (74%). Minor millet based blends KR_3, KS_2, KG_3, KSO_2, KuR_4, KuS_2, KuG_2 and $KuSO_2$ treatments showed the values of increased in volume as 90, 98, 106, 81, 74, 78, 108 and 112% in terms of foam volume increase respectively. Papad KuR_4, KuS_3 and KuG_2, $KuSO_2$ were statistically at par with each other.

4.4 Proximate Analysis

The blending of cereals with pulses grits in formulation of minor millet papad affected the proximate composition of papad. The results for the different biochemical parameters are given in Table 12 and graphically depicted through Figure 4.

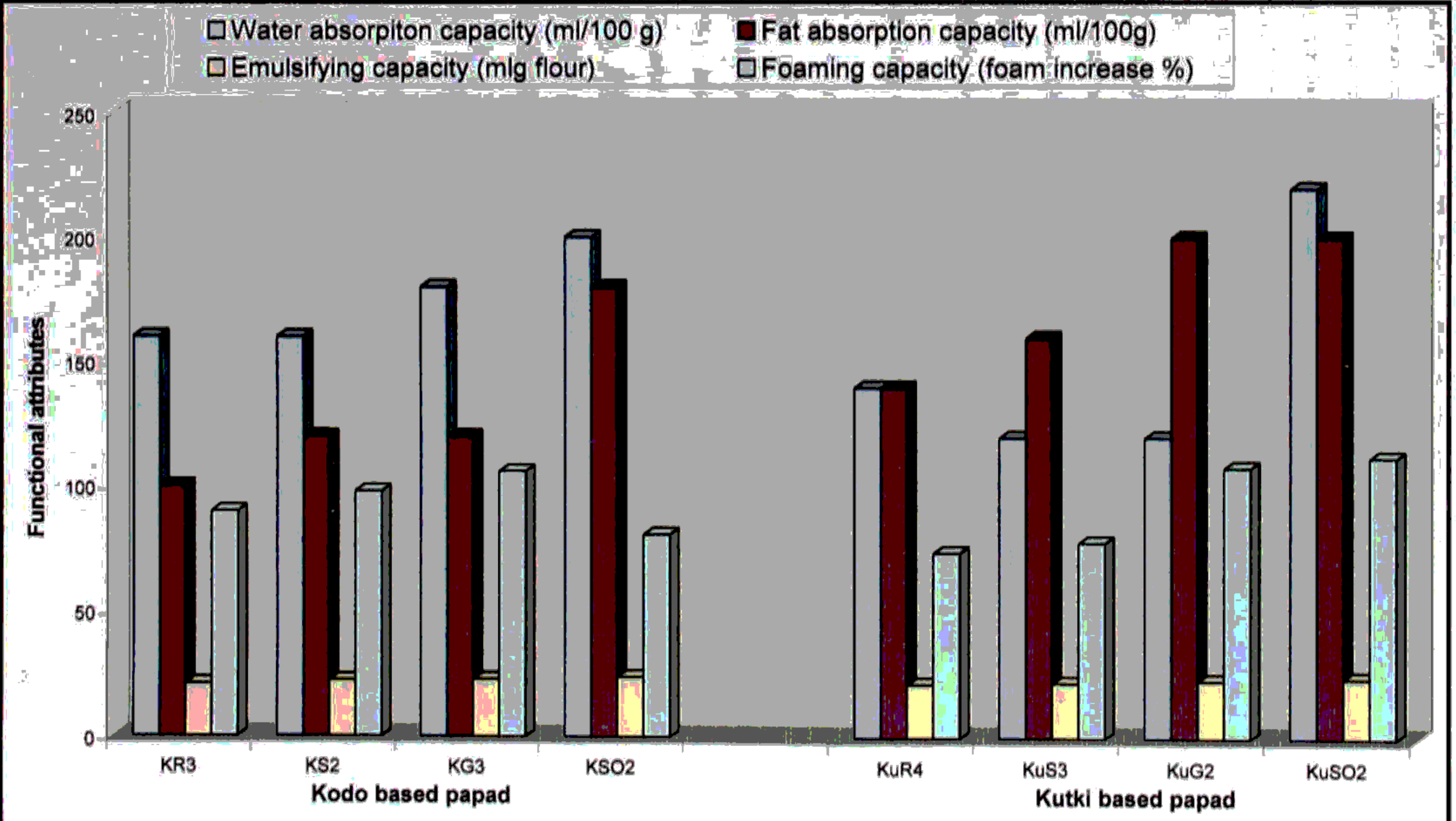


Figure 3. Functional attributes of kodo and kutki based papad

Table 12. Proximate analysis minor millet based papad

S. No.	Treatments	Combinations	Proximate parameters (%)						
			MC	Protein	Fat	Ash	Carbohydrate	Fiber	EV (Kcal)
Kodo based papad	KR_3	40 : 60	11.45	8.7	1.87	**1.16**	70.33	3.80	333.02
	KS_2	60 : 40	**12.2**	9.13	1.9	1.78	71.37	4.46	339.38
	KG_3	85 : 15	**11.12**	10.06	1.4	1.76	63.39	7.3	**306.36**
	KSO_2	90 : 10	11.5	**11.98**	3.03	**3.05**	**59.87**	3.7	315.53
	SEm±	-	0.195	NS	0.127	0.046	0.177	0.095	0.151
	CD at 5%	-	0.56	0.14	0.369	0.133	0.513	0.275	0.437
Kutki based papad	KuR_4	20 : 80	11.83	**6.9**	**1.36**	1.75	**74.3**	**2.69**	336.34
	KuS_3	40 : 60	11.15	7.7	2.01	2.25	73.08	**7.46**	**349.20**
	KuG_2	90 : 10	11.68	8.9	2.8	1.90	66.66	6.97	326.85
	$KuSO_2$	90 : 10	11.64	11.43	**5.69**	1.85	66.3	7.2	333.68
	SEm±	-	NS	0.132	0.060	0.034	0.146	0.073	0.149
	CD at 5%	-	1.681	0.382	0.175	0.098	0.423	0.213	0.431

MC = moisture content, EV = Energy value

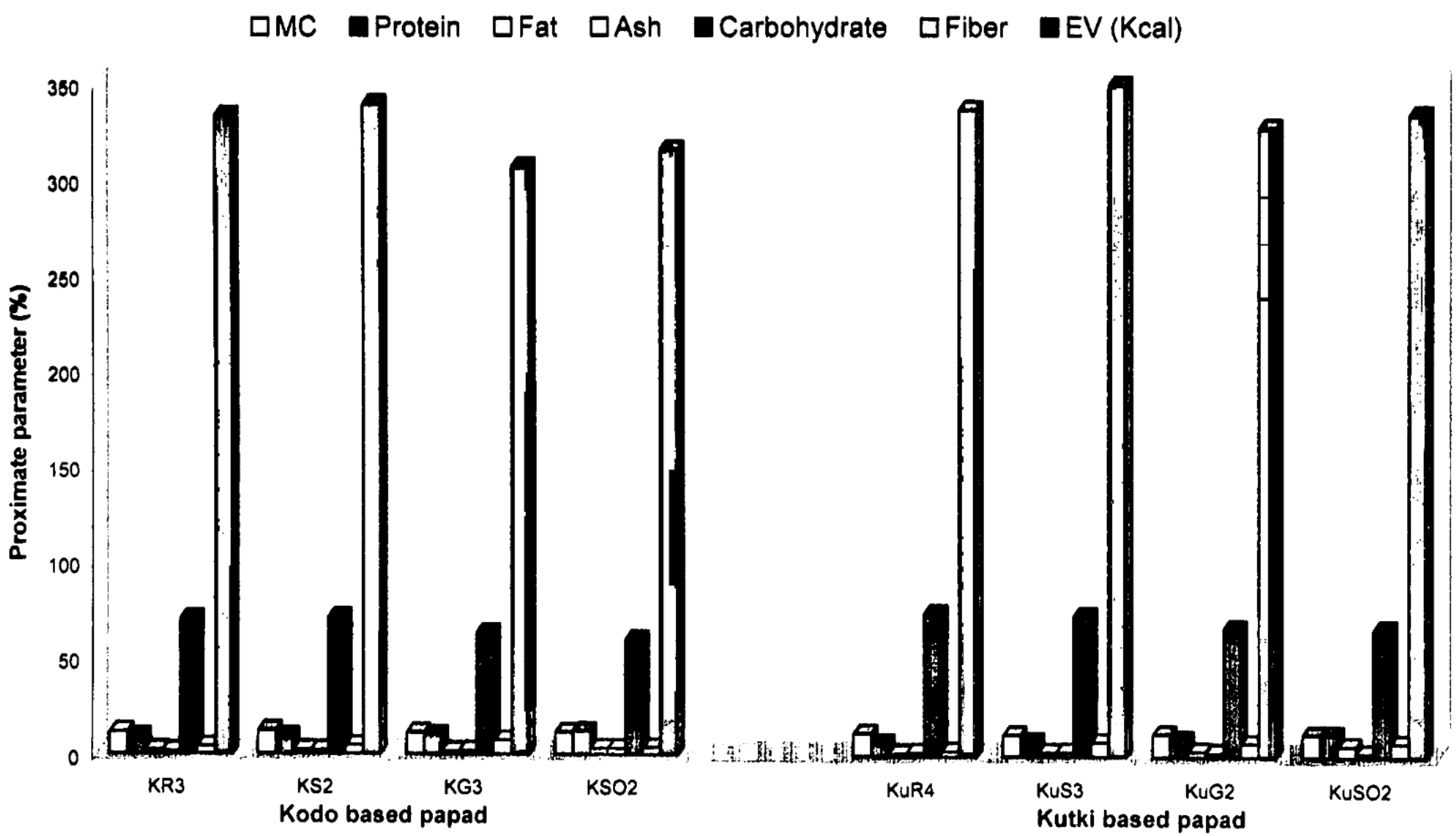


Figure 4. Proximate analysis kodo and millet based papad

increasing in blending ratio 90:10. The highest value (5.69) obtained by $KuSO_2$ followed by KSO_2 (3.03), KuG_2 (2.8), KuS_3 (2.01), KS_2 (1.9) and KR3 (1.87). 10% soy fortification was significantly superior than other formulated minor millet based papad. Fortification of soybean in all millet papad increased fat percentage and significantly superior than other formulated millet based papad. Millet based KR_3, KS_2, KG_3 and KuR_4 papad statistically at par with each other.

Ash

The results also showed an increase in ash content in papad fortification with soybean though the difference was significant. The recorded values for ash were 1.16, 1.78, 1.76, 3.05, 1.75, 2.25, 1.90 and 1.85% with the combinations KR_3 to $KuSO_2$ respectively. Maximum ash content was found in KSO_2 3.05% whereas KR_3 obtained minimum value at 1.16%. Data showed that kutki based soy fortified papad was significantly superior than other formulated millet based papad.

Carbohydrate

It can be seen from the results that carbohydrate values were lower in all pulses (green gram and soybean) combinations as compared to cereals (rice). The highest value carbohydrate was recorded in KuR_4 (74.3%), which was reduced to 73.08, 71.37, 70.33, 66.66, 66.3, 63.39 and 59.87 with the treatments KuR_4, KuG_2, KS_2, KR_3, KuS_2, KG_3 and KSO_2. Minor millet based papad KSO_2 got the lowest value (59.87%). KR_3, KS_2 and KuG_2 papad were statistically at par with each other. It can be seen from the results supplementation of pulses decreased the carbohydrate content in kodo fortified papad. Kodo+sago (KS_2) were significantly superior than other formulated papad. Carbohydrate content was noticed significantly superior in sago and rice fortified minor millet papad. Minor millet papad KR_3, KS_2, KuR_4, KuG_2, KuS_2 and KSO_2 were statistically at par with each other.

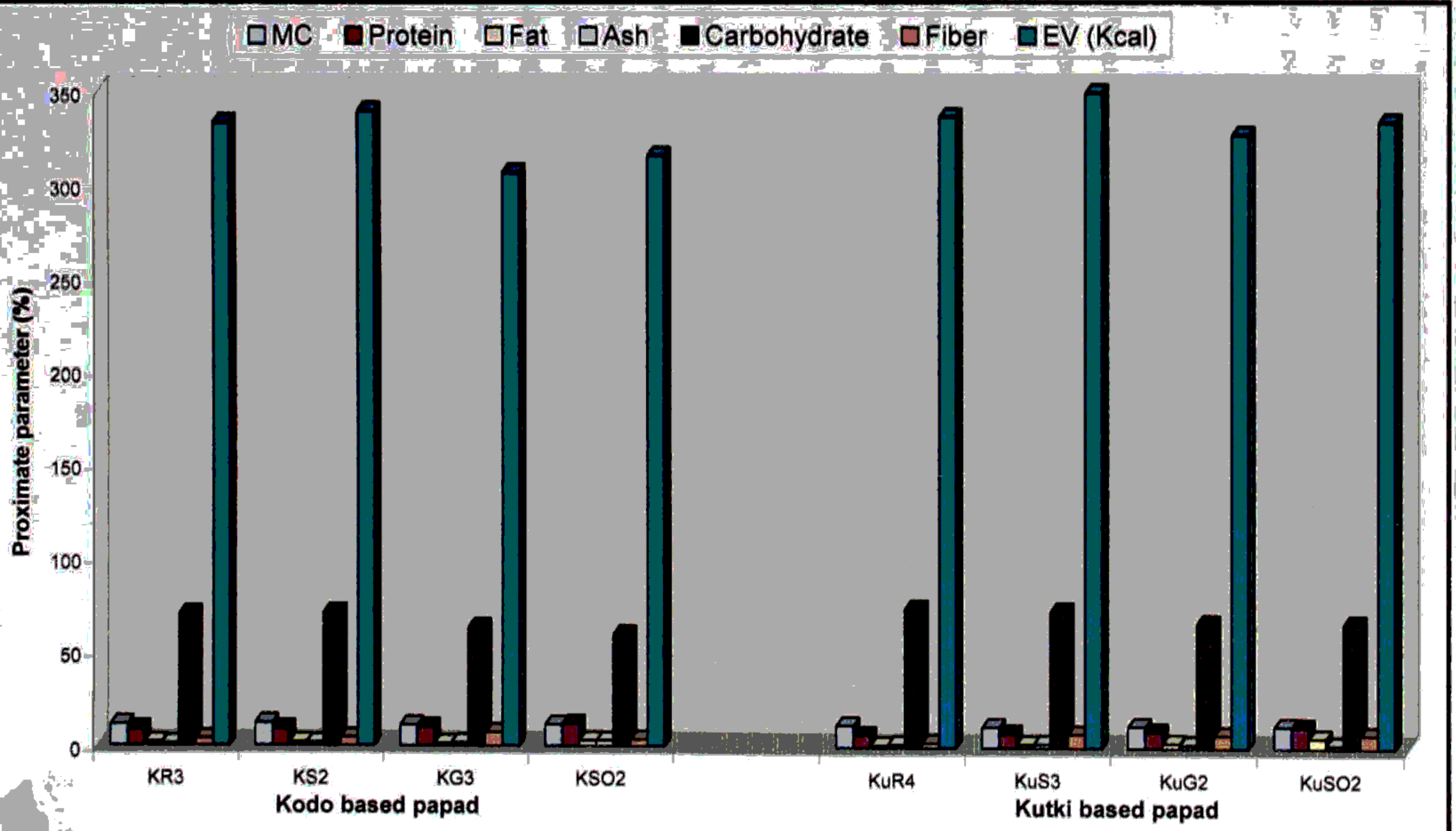


Figure 4. Proximate analysis kodo and millet based papad

results that calcium content was increased in all the pulse supplemented fortified papad. The supplementation of 10% soybean increased the calcium content in minor millet based papad. Soy fortified papad were significantly superior incase of calcium content. Rice and sago fortified kodo based papad were at par with each other.

Table 13. Mineral content of millet fortified papad

Papads	Treatments	Combinations	Minerals mg/100g papad		
			Calcium	**Phosphorus**	**Iron**
Kodo based papad	KR_3	40 : 60	16.83	171.2	0.62
	KS_2	60 : 40	16.26	112.8	3.73
	KG_3	85 : 15	34.26	220.8	1.01
	KSO_2	90 : 10	**48.36**	238.2	1.49
	SEm±	-	0.066	0.303	0.050
	CD at 5%	-	0.192	0.875	0.144
Kutki based papad	KuR_4	20 : 80	11.4	172.66	2.40
	KuS_3	40 : 60	**6.73**	**88.5**	**0.26**
	KuG_2	90 : 10	22.8	238.5	8.77
	$KuSO_2$	90 : 10	39.4	**266.33**	**9.46**
	SEm±	-	0.097	0.431	0.078
	CD at 5%	-	0.282	1.245	0.226

Phosphorus

In appraisal of the table 13 showed that the phosphorous content in minor millet based papad varied from 88.5 mg/100g to 266.33 mg/100g. The highest phosphorus content was observed in $KuSO_2$ (266.33 mg/100g) and lowest in KuS_3 (88.5 mg/100g). The addition of pulses flour showed a remarkable increased in phosphorus content. KG_3, KuG_2 and KSO_2 fortified papad were statistically at par with each other. $KuSO_2$ papad was significantly superior than other fortified millet based papad.

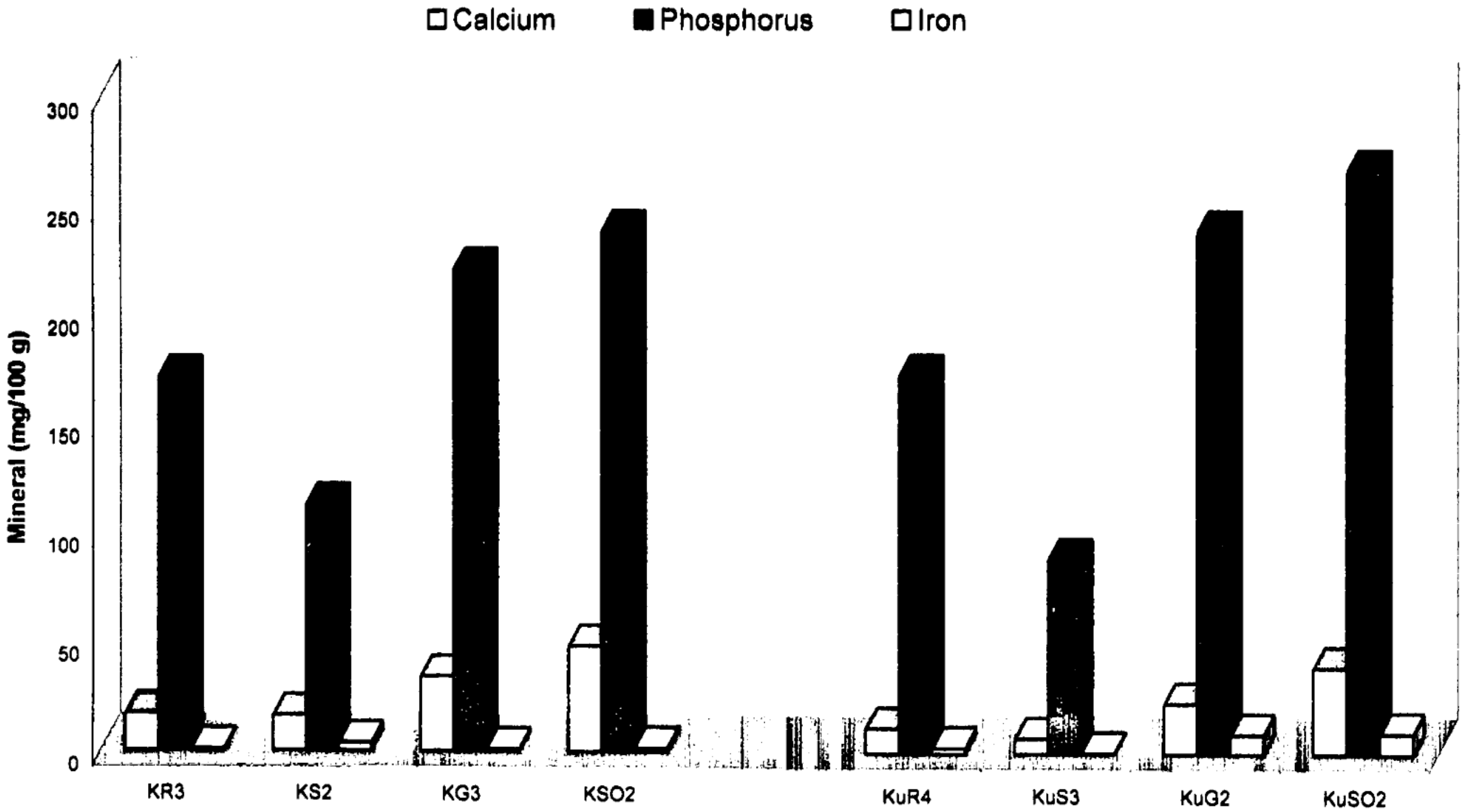


Figure 5. Mineral content of kodo and kutki based fortified papad

Iron

A perusal of Table 13 showed that the iron content varied from 0.26 to 9.46 mg/100g. The highest amount was recorded in $KuSO_2$ (9.46 mg/100g) and lowest in KS_2 (0.26 mg/100g). The supplementation of soybean is increased the iron content of the minor millet based papad. Kutki based soy fortified papad significantly superior than other formulated papads.

4.6 Colour analysis of minor millet based papad

Table 14. Colour analysis for minor millet based papad

Papads	Treatments	Combination	L	a	B
Kodo based papad	KR_3	40 : 60	19.84	1.77	5.63
	KS_2	60 : 40	**25.76**	1.31	6.27
	KG_3	85 : 15	27.14	2.66	8.00
	KSO_2	90 : 10	**18.72**	2.31	6.03
Kutki based papad	KuR_4	20 : 80	23.67	**1.14**	6.48
	KuS_3	40 : 60	20.61	1.30	**5.00**
	KuG_2	90 : 10	21.24	3.60	7.10
	$KuSO_2$	90 : 10	24.59	**3.81**	**8.65**

It is cleared from the results that addition of soybean and rice added in fortified papad reduced the L – values. The highest value (27.14) was obtained from KG_3, followed by 25.76 (KS_2), 24.59 ($KuSO_2$), 23.67 (KuR_4), 21.24 (KuG_2), 20.61 (KuS_3) and 19.84 (KR_3) while the lowest value 18.72 was obtained from KSO_2. The a – value were highest for $KuSO_2$ (3.81) and lowest for (1.14) obtained from KuR_4, while KR_3, KS_2, KG_3, KSO_2, KuS_2 and KuG_2 obtained 1.77, 1.31, 2.66, 2.31, 1.30 and 3.60 respectively. The highest b – value (8.65) was obtained by $KuSO_2$ and lowest (5.00) in KuS_3. The data showed that the formulation of fortified papad significantly influence the colour of papad.

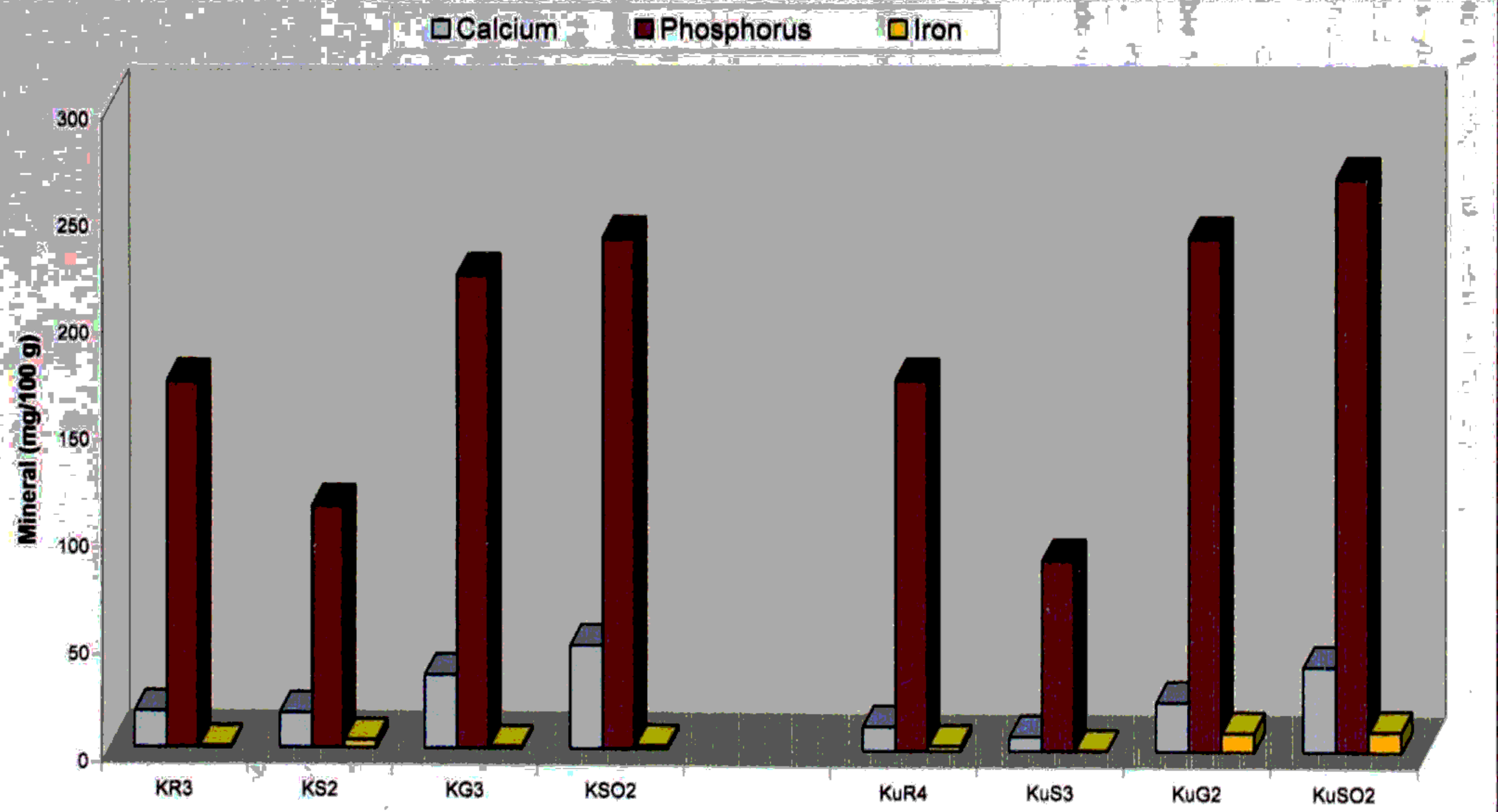


Figure 5. Mineral content of kodo and kutki based fortified papad

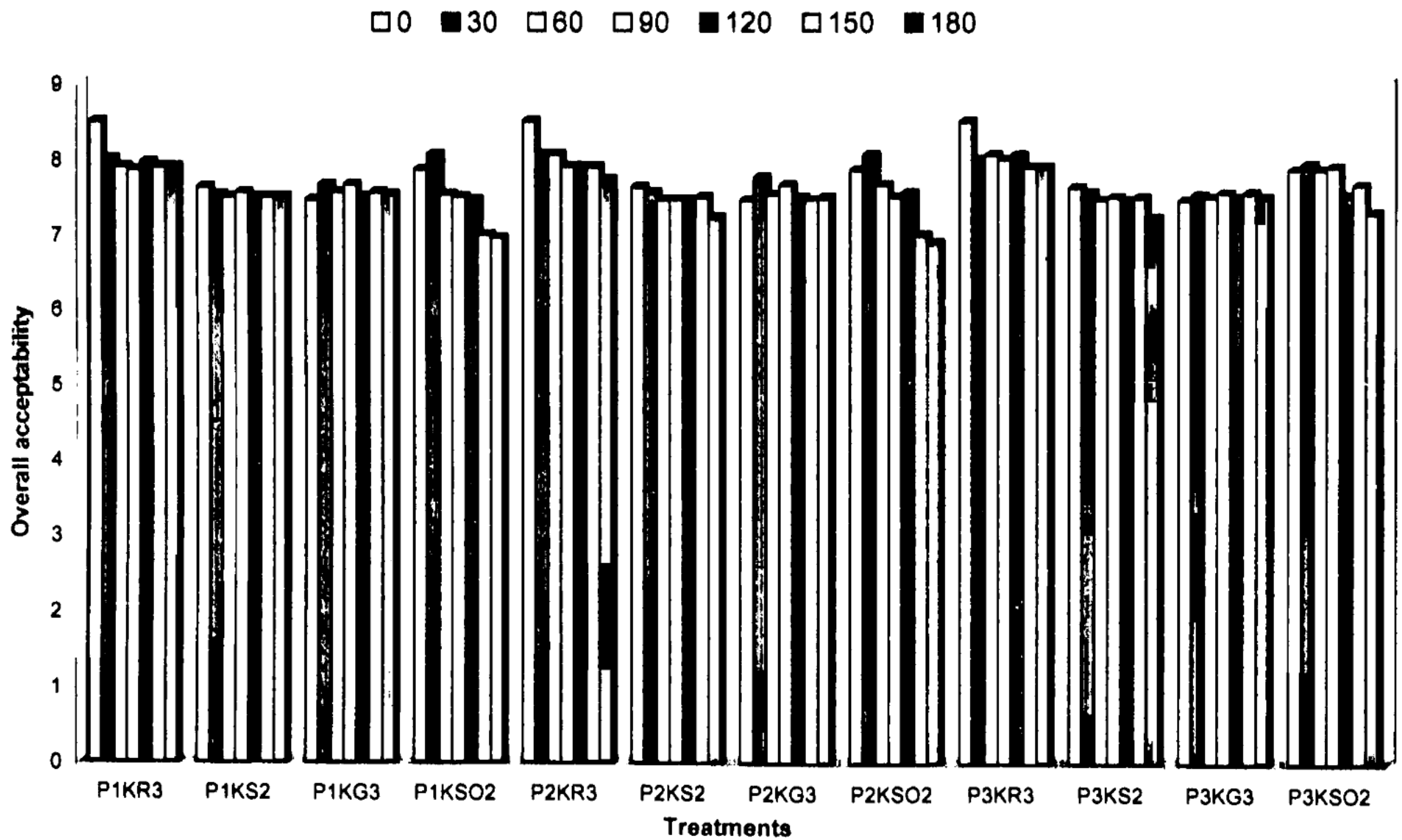
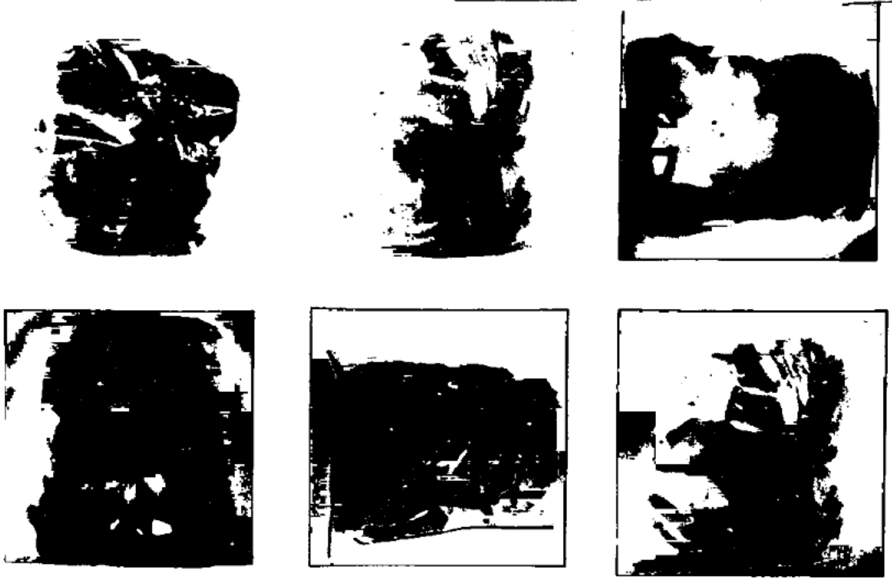
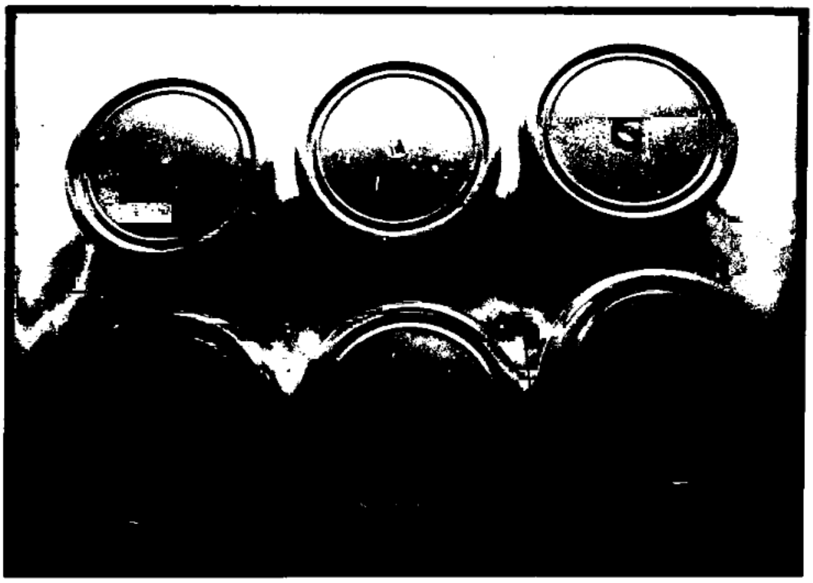


Figure 6. Effect of storability on the overall acceptability of kodo based fortified papad



LDPE
(Low density polyethylene)



Plastic box

Steel box

Plate No 5 - Storage of minor millets papad in different packaging materials

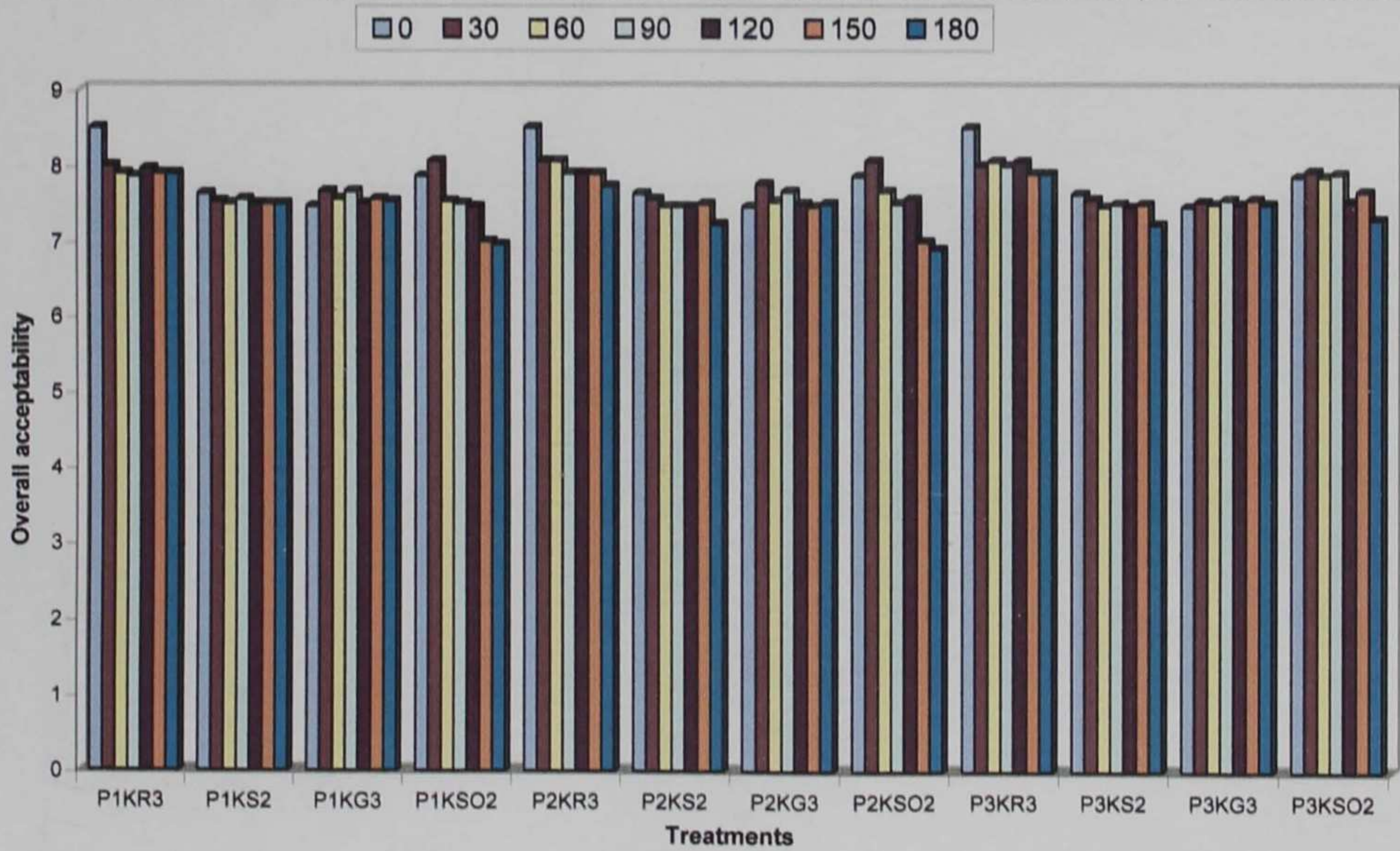
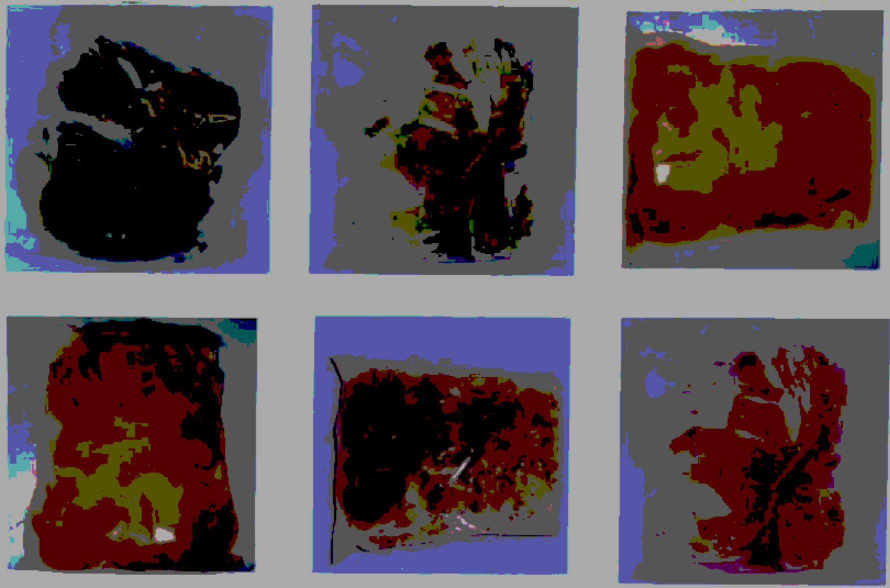
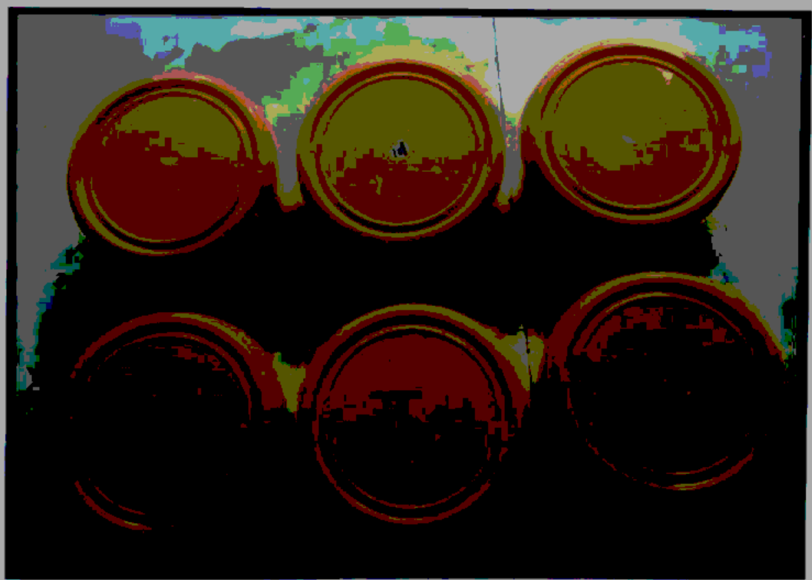


Figure 6. Effect of storability on the overall acceptability of kodo based fortified papad



LDPE
(Low density polyethylene)



Plastic box

Steel box

Plate No 5 - Storage of minor millets papad in different packaging materials

4.7.3 Effect of storability on the moisture content of kodo fortified papad

The results were observed to be the same as all of the formulations were subjected to the low density polyethylene bags, plastic box and steel boxes during storage. The highest mean scores was observed 180 days after storage at 12.42, 12.36 and 12.24 from KS_2 in plastic box, low density polyethylene bags and steel box respectively while the lowest mean scores in initial stage of storage 11.15 were observed from KG_3 in low density polyethylene bags, plastic box and steel box respectively. The results showed that (steel box) P_3 packaging material did not affect reasonably to moisture content of stored fortified papad during storage (Table 17 and Figure 8).

Table 17. Effect of storability on moisture content of kodo based fortified papads

Treatments	Storage (Days)						
	0	30	60	90	120	150	180
P_1KR_3	11.47	11.45	11.47	11.45	11.56	11.50	11.81
P_1KS_2	**12.20**	**12.20**	**12.20**	12.20	**12.27**	**12.29**	12.36
P_1KG_3	**11.15**	**11.15**	**11.15**	**11.15**	**11.15**	11.18	11.24
P_1KSO_2	11.56	11.50	11.56	11.50	11.63	11.72	11.78
P_2KR_3	11.47	11.45	11.47	11.47	11.47	11.49	11.57
P_2KS_2	**12.20**	**12.20**	**12.20**	**12.21**	12.26	12.23	**12.42**
P_2KG_3	**11.15**	11.14	**11.15**	11.15	11.19	11.23	11.24
P_2KSO_2	11.56	11.50	11.56	11.64	11.68	11.73	11.80
P_3KR_3	11.47	11.65	11.47	11.45	11.47	11.45	11.47
P_3KS_2	**12.20**	11.89	**12.20**	12.20	12.20	12.20	12.24
P_3KG_3	**11.15**	11.21	**11.15**	**11.15**	**11.15**	**11.15**	**11.17**
P_3KSO_2	11.56	11.48	11.56	11.50	11.56	11.50	11.57
SEm ±	0.065	0.086	0.065	0.041	0.046	0.057	0.032
CD at 5%	0.188	0.250	0.188	0.120	0.135	0.166	0.093

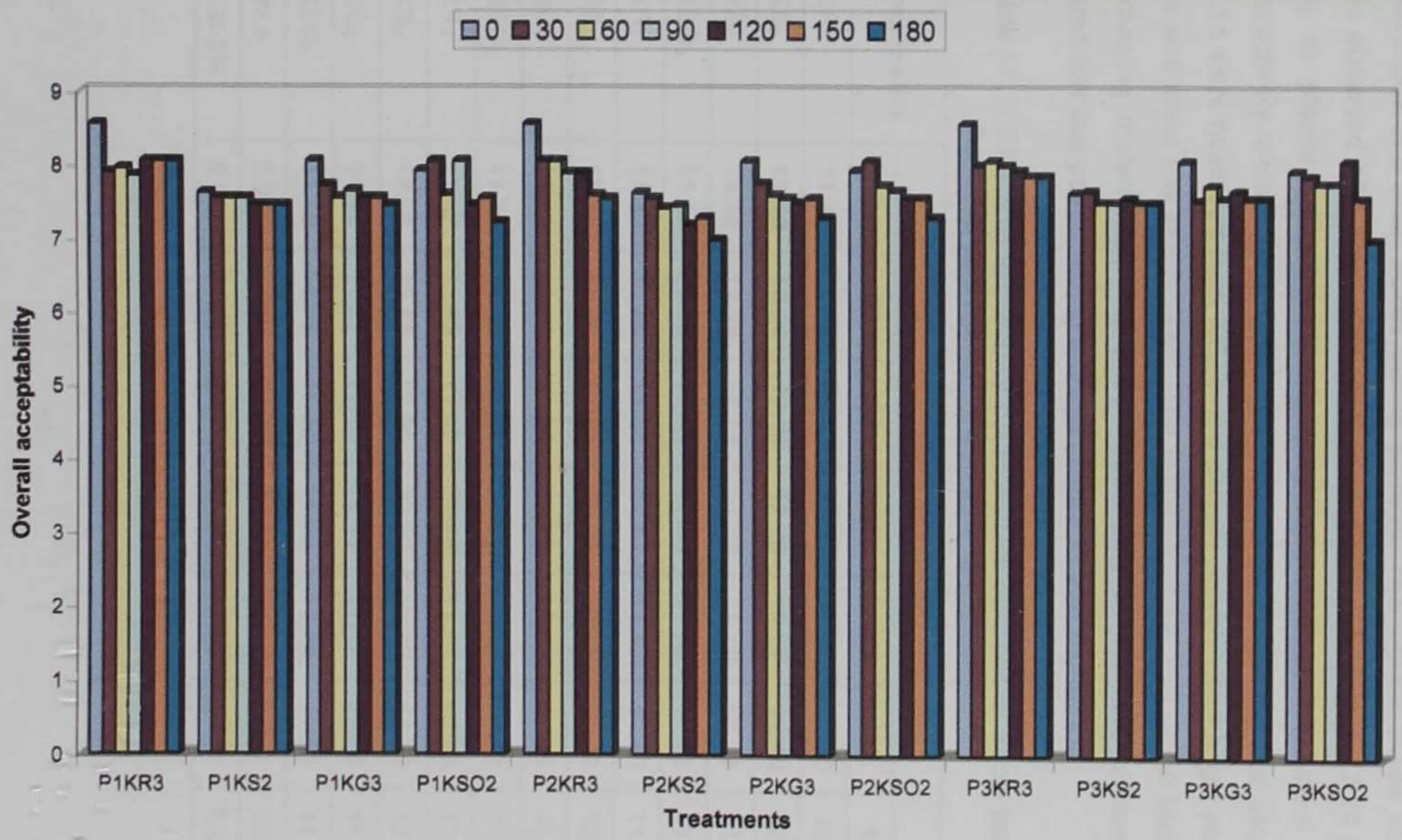


Figure 7. Effect of storability on the overall acceptability of kutki based fortified papad

4.7.4 Effect of storability on the moisture content of kutki fortified papad

The results were observed to be the same as all of the formulations were subjected to the low density polyethylene bags, plastic box and steel boxes during storage. The highest mean scores observed 180 days after storage at 12.18, 12.08 and 12.02 from KuG_2 in plastic box, low density polyethylene bags and steel box respectively while the lowest mean scores in initial stage of storage 11.21 were observed from KuS_3 in low density polyethylene bags, plastic box and steel box respectively. The results showed that (steel box) P_3 packaging material did not affect reasonably to moisture content of stored kutki fortified papad during storage (Table 18 and Figure 9).

Table 18. Effects of storability on moisture content of kutki fortified papads

Treatments	Storage (Days)						
	0	30	60	90	120	150	180
P_1KR_3	11.65	11.65	11.65	11.65	11.65	11.6	11.69
P_1KS_2	**11.21**	**11.15**	**11.22**	**11.22**	11.22	**11.21**	11.27
P_1KG_3	**12.01**	**12.01**	**12.01**	**12.01**	12.01	12.03	12.08
P_1KSO_2	11.65	11.65	11.65	11.65	11.65	11.67	11.71
P_2KR_3	11.65	11.65	11.65	11.65	11.67	11.67	11.69
P_2KS_2	**11.21**	**11.15**	**11.22**	**11.22**	11.20	11.24	11.26
P_2KG_3	**12.01**	**12.01**	**12.01**	**12.01**	**12.10**	**12.12**	**12.18**
P_2KSO_2	11.65	11.65	11.65	11.65	11.66	11.68	11.71
P_3KR_3	11.65	11.65	11.65	11.65	11.65	11.65	11.67
P_3KS_2	**11.21**	**11.15**	**11.22**	**11.22**	**11.21**	**11.21**	**11.22**
P_3KG_3	**12.01**	**12.01**	**12.01**	**12.01**	12.01	12.01	12.02
P_3KSO_2	11.65	11.65	11.65	11.65	11.65	11.65	11.75
SEm ±	0.037	0.035	0.041	0.035	0.030	0.020	0.061
CD at 5%	0.108	0.101	0.119	0.101	0.088	0.081	0.174

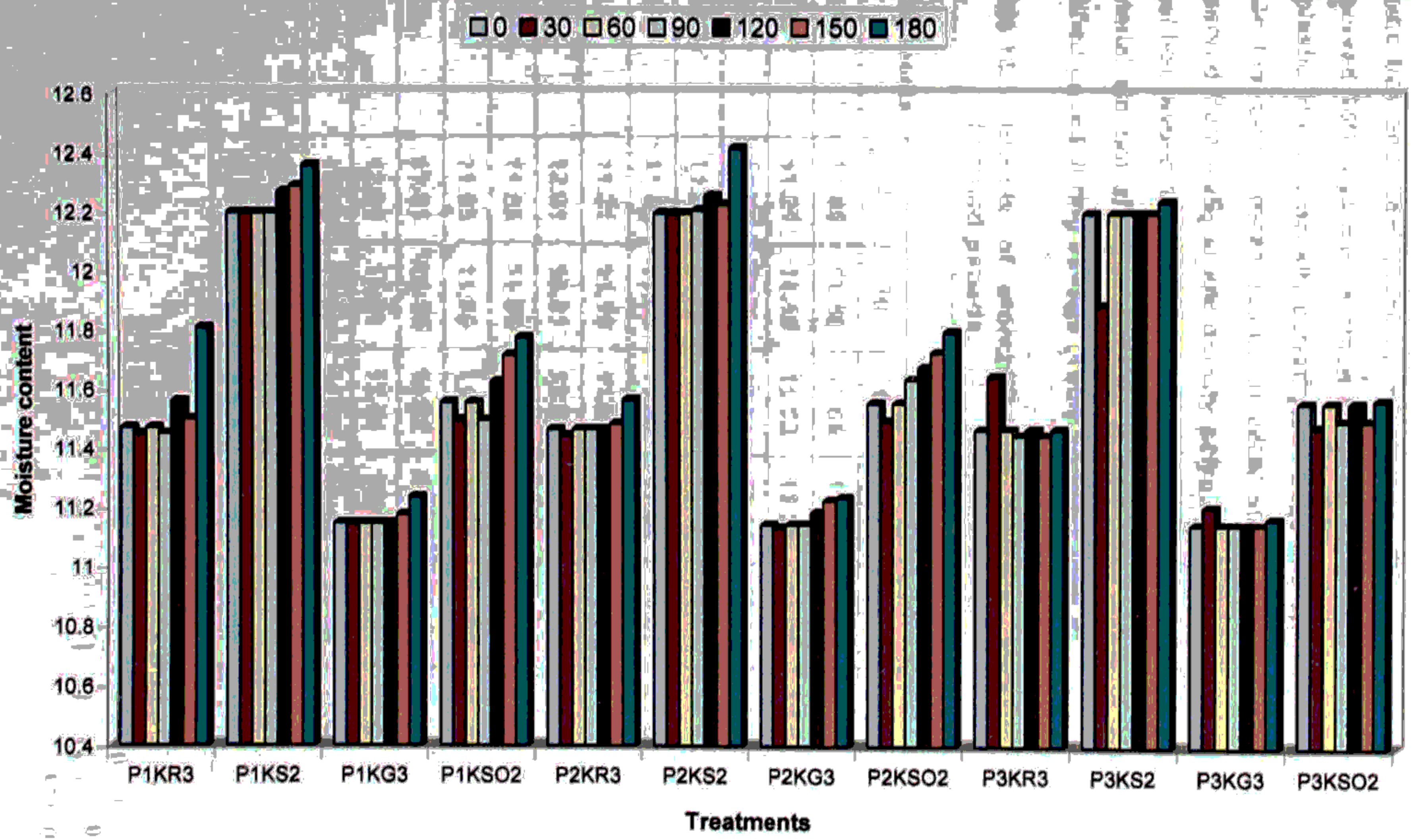


Figure 8. Effect of storability on moisture content of kodo fortified papads

4.6.5 Effect of storability on the free fatty acid content of kodo based papad

Below 120 days there was not found free fatty acids in all treatments. The storage of different kinds of blended papad with and without addition of pulses and sago flour stored in low density polyethylene, plastic box and steel box for the period of 180 days at ambient temperature revealed that the average value of free fatty acid content was minimum 1.05 and 1.2 respectively, in the P_1KR_3 and P_3KS_2 treatments (Table 19 and Figure 10).

Table 19. Effect of storability on free fatty acid (g of KOH/100 g of papad) of kodo fortified papads

Treatments	Storage (Days)						
	0	30	60	90	120	150	180
P_1KR_3	-	-	-	-	-	1.05	1.13
P_1KS_2	-	-	-	-	-	**0**	**0**
P_1KG_3	-	-	-	-	-	2.7	3.3
P_1KSO_2	-	-	-	-	-	**4.3**	**5.21**
P_2KR_3	-	-	-	-	-	1.23	1.27
P_2KS_2	-	-	-	-	-	0	1.05
P_2KG_3	-	-	-	-	-	1.7	3.3
P_2KSO_2	-	-	-	-	-	1.27	3.3
P_3KR_3	-	-	-	-	-	1.05	1.23
P_3KS_2	-	-	-	-	-	1.2	1.28
P_3KG_3	-	-	-	-	-	2.8	3.23
P_3KSO_2	-	-	-	-	-	3.5	3.9
SEm ±	-	-	-	-	-	0.086	0.062
CD at 5%	-	-	-	-	-	0.251	0.181

However, the soy fortified kodo papad contained higher values for free fatty acid, 5.21, 3.3 and 3.23 in low density polyethylene bags, plastic box and steel box respectively after 180 days of storage. During storage there was a gradual increase in the fatty acid acidity in

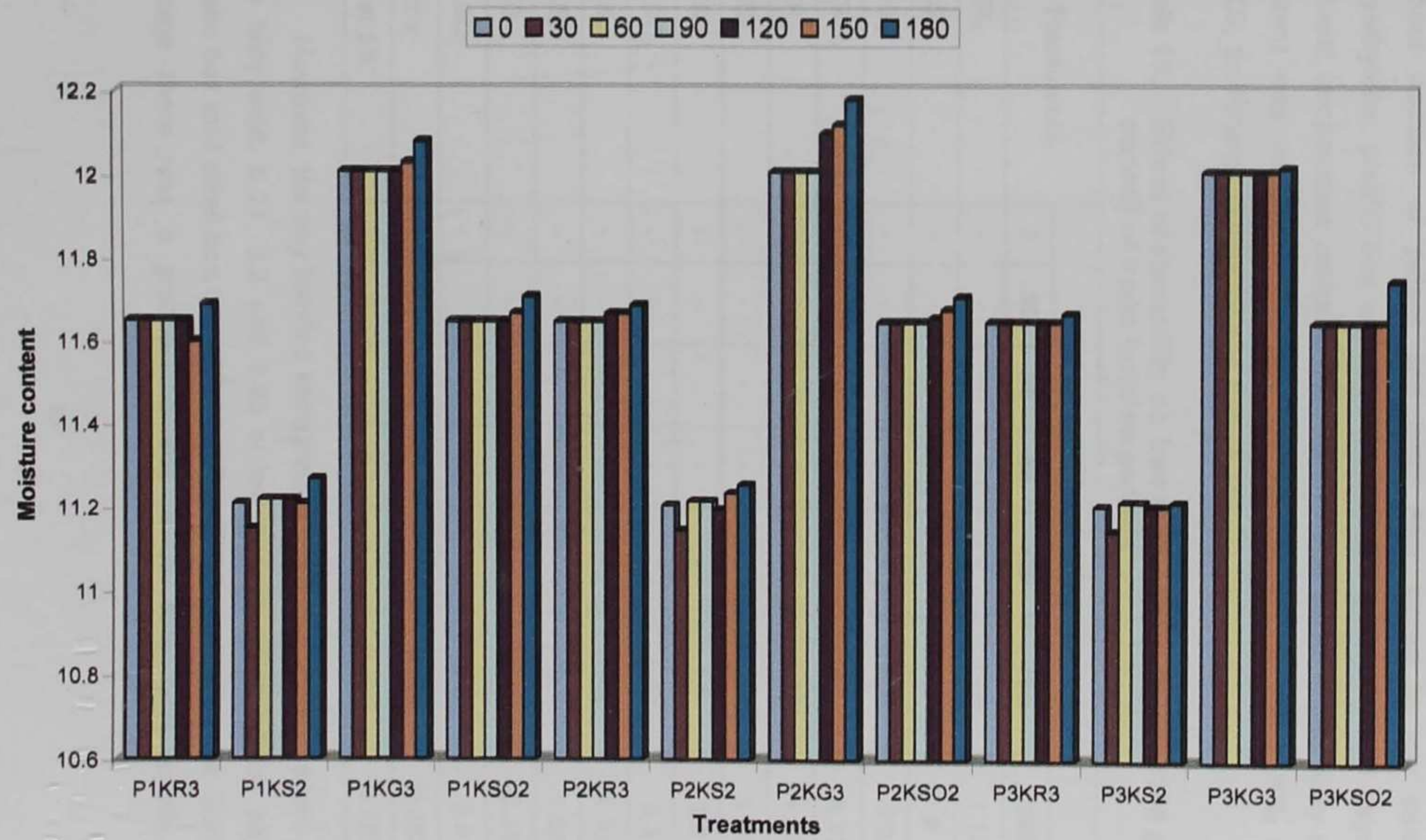


Figure 9. Effects of storability on moisture content of kutki fortified papads

kodo+soybean blend. The values were more or less the same in two packaging materials (plastic box and steel box). This indicates that both the packaging materials could be considered the safest for storage of products but low density polyethylene bags was not consider at house hold level. It is evident from the table that the supplementation of soy flour increased free fatty acid in fortified papad.

4.6.6 Effect of storability on the free fatty acid content of kutki based papad

The storage of different kinds of blended papad with and without addition of pulses flour stored in low density polyethylene bags, plastic boxes and steel boxes for the period of 180 days at ambient temperature revealed that the average value of free fatty acid content was minimum 1.05 and 1.23 respectively, in the P_2KuS_3 and P_3KuR_4.

Table 20. Effect of storability on free fatty acid (g of KOH/100 g of papad) of kutki fortified of papads

Treatments	Storage (Days)						
	0	30	60	90	120	150	180
P_1KR_3	-	-	-	-	-	1.13	1.5
P_1KS_2	-	-	-	-	-	0	0
P_1KG_3	-	-	-	-	-	3.5	4.2
P_1KSO_2	-	-	-	-	-	**4.3**	**5.21**
P_2KR_3	-	-	-	-	-	1.23	1.27
P_2KS_2	-	-	-	-	-	0	1.05
P_2KG_3	-	-	-	-	-	2.7	3.3
P_2KSO_2	-	-	-	-	-	**4.3**	**5.21**
P_3KR_3	-	-	-	-	-	1.05	1.23
P_3KS_2	-	-	-	-	-	1.2	1.28
P_3KG_3	-	-	-	-	-	2.8	3.23
P_3KSO_2	-	-	-	-	-	3.5	4.3
SEm ±	-	-	-	-	-	0.069	0.055
CD at 5%	-	-	-	-	-	0.199	0.161

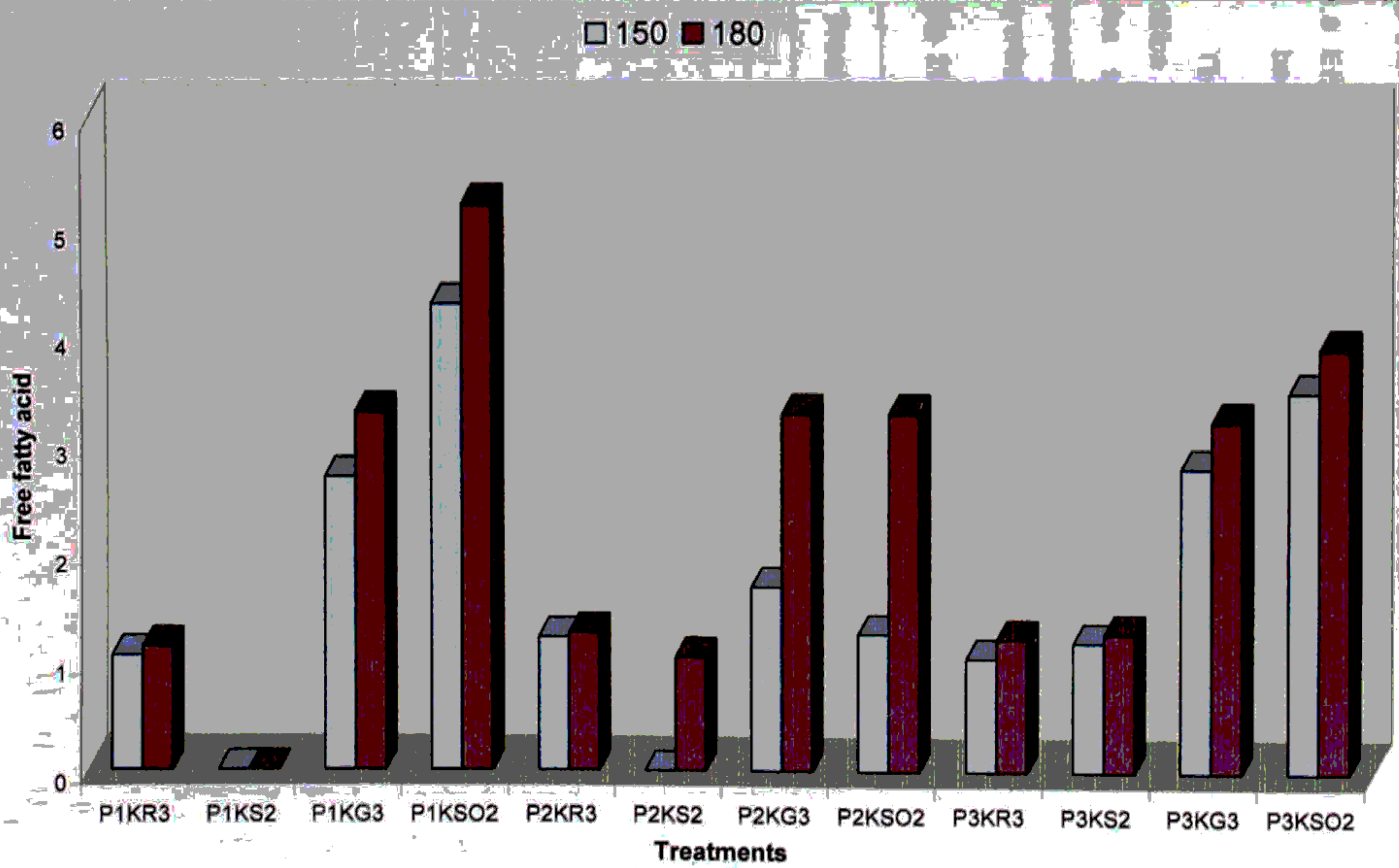


Figure 10. Effect of storability on free fatty acid (g of KOH/100 g of papad) kodo fortified papad

However, the soy fortified kutki papad contained higher values for free fatty acid, 5.21 in low density polyethylene bags, plastic box and steel box respectively after 180 days of storage. During storage there was a gradually increases in the fatty acid acidity in kodo+soybean blend but in P_1KuS_3 was not found in FFA during storage period. The values were more or less the same in two packaging materials (plastic box and steel box). This indicates that both the packaging materials could be considered the safest for storage of products but low density polyethylene bags was not consider at house hold level. It is evident from the table that the fortification of soy flour increased free fatty acid in fortified papad (Table 20 and Figure 11).

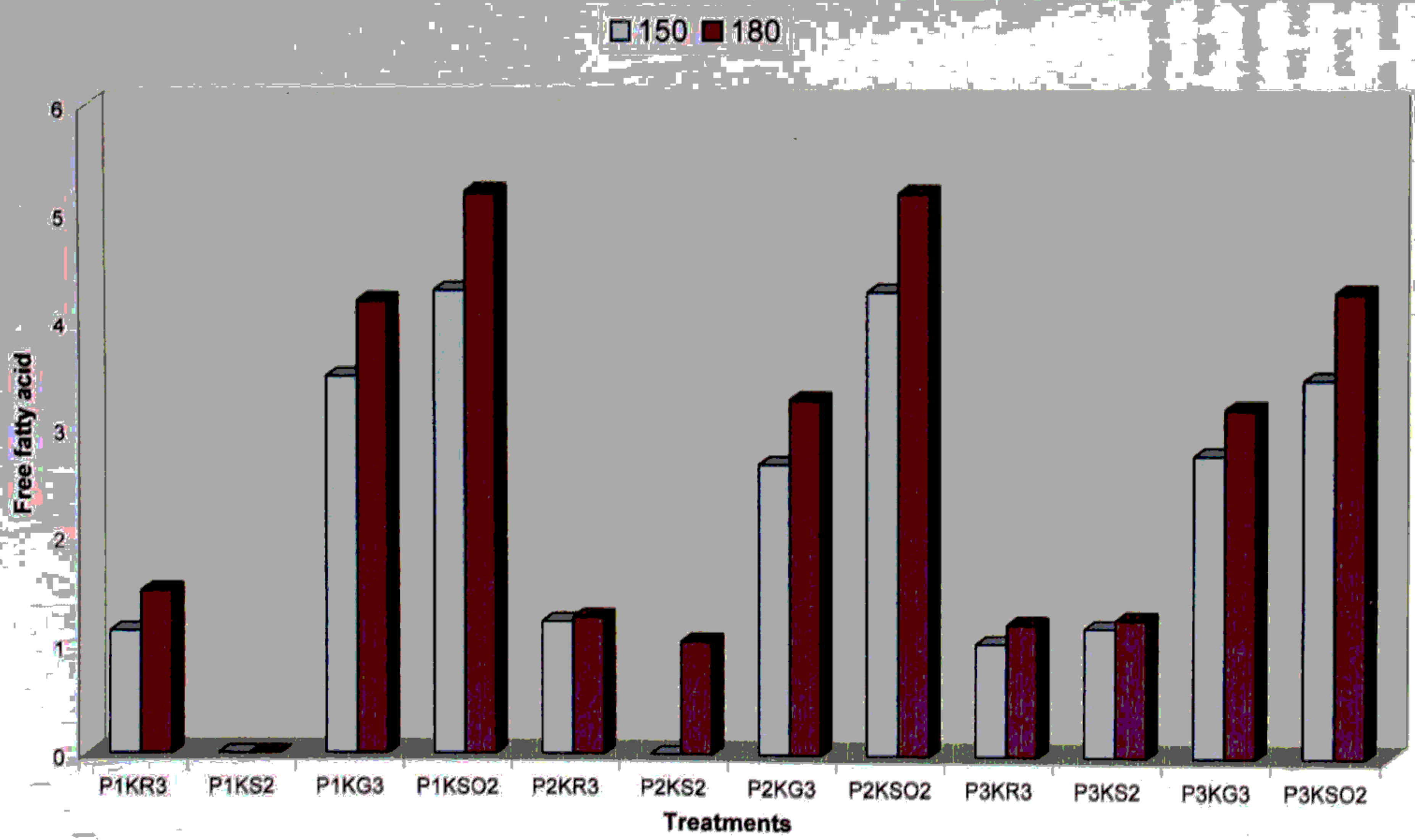


Figure 11. Effect of storability on free fatty acid (g of KOH/100 g of papad) kutki fortified papad

DISCUSSION

This chapter deals with the justification of the experimental findings under taken in the proposed research programme. The results have been explained with the help of reported values of various parameters given by different workers. The results have already been given in detail in the preceding chapter.

5.1 Overall acceptability of fortified minor millet papad

The results of overall acceptability of fortified papad made by incorporating different ratio of kodo, kutki, rice, sago, soy and green gram have given in Tables 2 to 9.

In case of kodo fortified rice papad KR_3 (kodo + rice) formulated papad had more acceptable than other rice fortified kodo papad, whereas KR_1 (kodo+rice) formulated papad had lowest value. The results showed that the combination of 40% kodo and 60% rice increased the overall acceptability of kodo fortified rice papad. This might be due to color attraction, taste and aroma of papad.

In case of sago fortified kodo formulated papad KS_2 was better as compared to control papad, whereas KS_5 formulated papad had lowest score in acceptability. From the results we found that fortification of sago in kodo 40% increased the overall acceptability of papad. This might be due to color, taste of papad after fortification of sago. Similar finding have been reported by Vidyavati *et al,* (2004).

Kodo fortified papad was more acceptable when it was formulated with green gram. It is clear from the data KG_3 (Kodo:Green gram 85:15) formulated green gram fortified kodo papad had better score for overall acceptability whereas, KG_0 had least acceptability. The data showed that the incorporation of mung flour increase the acceptability of millet papad upto 15%. This might be due to texture, color, flavour and taste of papad. These results have been observed by

Singh *et al.*, (1996) in overall acceptability was not affected significantly up to 10% level of blending of mung flour.

Kodo fortified papad was more acceptable when it was formulated with soybean. It is clear from the data KSO_2 (Kodo:Soybean 90:10) formulated soybean supplemented papad had better score for overall acceptability whereas, KSO_1 had least acceptability. Overall acceptability of millet papad was increased with fortification upto limit than decreased. This might be due to taste, texture, flavour and colour of papad. Similar finding have been reported by Deepa *et al.* (1992) by incorporating soy flour to the black gram.

In case of rice fortified kutki papad KuR_4 (kutki + rice 20:80) formulated papad had more acceptable than other rice fortified kutki papad. Whereas KuR_5 (kutki+rice 0:100) formulated papad had lowest value. The results showed that the increased combination of rice in kutki based papad increase the overall acceptability of fortified papad. This might be due to color attraction, taste and aroma of papad.

In case of sago fortified kutki papad formulated papad KuS_3 had better as compared to control papad, whereas KuS_1 formulated papad had lowest score in acceptability. From the results we found that fortification of sago in kutki decreased the overall acceptability upto limit. This might be due to color, taste and texture of papad after fortification. Similar finding have been reported by Vidyavati *et al.* (2004).

Kutki fortified papad was more acceptable when it was formulated with green gram. It is clear from the data KuG_2 (Kodo:Greengram 90:10) formulated green gram fortified kutki papad had better score for overall acceptability whereas, KuG_4 had least acceptability. This might be due to texture, color, flavour and taste of papad. The data showed that the increased the blend ratio of green gram in millet papad increased the overall acceptability upto limit. These results have been observed by

Singh *et al.*, (1996) in overall acceptability was not affected significantly up to 10% level of blending of mung flour.

Soybean fortified papad was more acceptable when it was formulated with soybean. It is clear from the data $KuSO_2$ (Kutki:Soybean 90:10) formulated soybean supplementation papad had better score for overall acceptability whereas, $KuSO_4$ had least acceptability. This might be due to taste, texture, flavour and colour of papad. Similar finding have been reported by Deepa *et al.*(1992) Effect of incorporating soy flour in black gram papad.

5.2 Physical attributes of minor millet fortified papad

5.2.1 Bulk density (Flour)

Maximum bulk density was recorded in KG_3 and KuR_4 formulated fortified flour whereas minimum bulk density was found in KuG_2 fortified flour. It was found that fortification in minor millet (kodo and kutki) increased the rate of bulk density except fortification of soybean in papad.

In case of fortified papad maximum bulk density was recorded in $KuSO_2$ and control formulated fortified papad whereas minimum bulk density was found in KG_3 and KSO_2 fortified papad. It was found that increases fortification in papad bulk density decreased, except soy fortified kutki papad. These finding have been supported by Kinsella (1979).

5.2.3 Expansion ratio

From the table we found that the minimum expansion ratio was in KG_3 whereas minimum expansion ratio was observed in $KuSO_2$. The expansion ratio of papads negatively correlated with the moisture content of raw and fried papads. A similar finding was reported by Senthil *et al.* (2002) in quality characteristics of black gram papad or Kulkarni *et al.* (1996).

5.3 Functional attributes of minor millet fortified papad

5.3.1 Water absorption capacity

Water binding capacity plays an important role it depends on the availability of hydrophilic groups that bind water molecular and on the gel forming capacity of macromolecules. It is evident from the tables and figures that maximum WAC was found in $KuSO_2$ kutki:soybean fortified papad, whereas minimum was found in KuG_2, KuS_3 fortified papad water absorption capacity was increase with fortification of soybean flour in kodo and kutki based papad. Several workers have also reported that the soy proteins have got better WAC in comparison to other legume proteins (Lin *et al.*, 1974, Wu and Inglett, 1974; Tasneem *et al.*, 1982)

5.3.2 Fat absorption capacity

It is evident from the table and figures that maximum fat absorption capacity was found in $KuSO_2$ and KuG_2 fortified papad, whereas minimum was found in KS_2, KG_3 fortified papad. This increase in the fat absorption capacity values with the increasing level of blending of soy flour and green gram, might be due to the physico chemical characteristics of lipophilic proteins present in soyflour. Many reports have been published in the literature that the lipophilic proteins show superior binding of lipids, thereby implying that the non-polar amino acid residues bind the paraffin chains of the fat (Kinsella, 1976).

5.3.3 Emulsifying capacity

It was seen that with the fortification of kodo and kutki at different levels, the maximum emulsifying capacity values are recorded $KuSO_2$ and KSO_2. Studies have shown that the emulsion properties of flour cannot be solely attributed to the protein, but other food components such as carbohydrates and lipids might also contribute appreciably, possible through protein carbohydrate and protein lipid interaction (Dev and Mukherjee, 1986, Pawar and Ingle, 1988, Diwakar *et al.*, 1996).

5.3.4 Foaming capacity

It is evident from the data obtained that maximum foaming capacity was found in soy fortified kutki papad whereas minimum was found in rice fortified kutki papad. Incorporation of soy flour and green gram flour blends resulted in the relative increase in the foam volume of the various fortified blends. It is already known that foamability is assumed to be dependent on the configuration of the protein molecules. Various studies have shown that flexible protein molecules give good foamability, but highly ordered globular molecules give low foamability, because they cannot reduce the surface tension of the air water interface (Grahm and Phillips, 1976).

5.4 Proximate attributes

5.4.1 Moisture

The maximum moisture content was found in (KS_2 kodo:sago) papad in both millet papad, whereas minimum was found in KG_3 (kodo:green gram) formulated papad. Moisture content decreased with formulation of various pulses grits. This might be due to fortification of grains in minor millet. Similar findings have been supported by Rahman and Uddin (2008).

5.4.2 Protein

Protein content increased with incorporation of legumes flours. Table showed that maximum protein content was found in KSO_2 (kodo:soybean) fortified papad, whereas minimum was found in KuR_4 fortified papad. Different combination of papad supplemented with 10% soy flour was significantly superior than other formulated papad. This could be due to the supplementation of pulses flour in minor millet papad. Similar findings have been observed by Rahman and Uddin (2008) and Garg *et al.* (2003).

5.4.3 Fat

The fat content of fortified papad increased gradually among pulses supplemented papad. However, a significant increase was observed in soy supplemented papad at the 10% level in $KuSO_2$ papad. A sharp increased in fat content was observed with the addition of the soya flour in papad. This might be due to high content of oil. These results are close agreement with Rahman and Uddin (2008) in fat content of soya fortified papad.

5.4.4 Ash

The ash content of every kodo fortified papad was minimum and it remained almost the same in fortified kutki papad at all levels. Maximum ash con tent was found in KSO_2, whereas minimum was found in rice fortified kodo based papad. This might be due to supplementation of soy flour in fortified papad. Similar findings have been supported by Vidyavati *et al.* (2004).

5.4.5 Carbohydrate

The data showed that carbohydrate content was increased with formulation of high carbohydrate content grain flours in various papad. Maximum carbohydrate content was found in KuR_4 fortified papad, whereas minimum was found in KSO_2 papad. Results showed that carbohydrate content was significantly differ in all fortified papad. Carbohydrate Content was decreased with supplementation of soybean and green gram flours in all fortified papad. This might be due to the high carbohydrate content of the formulations is attributed the high carbohydrate content. Similar findings have been supported by Deepa *et al.* (1992).

5.4.6 Fibre

The table showed that the fibre content was increased with increasing the ratio of supplementation of sago and pulses. Maximum fibre content was found in KuS_3, whereas minimum was found in KuR_4 papad. These findings might be due to incorporation of sago and pulses which are rich source of fibre. Similar finding have been supported by Veena *et al.* (2012).

5.3.7 Energy Value

Energy value was observed to be high for all formulated fortified papad. Maximum percentage was found in $KuSO_2$ sago fortified kutki papad, whereas minimum was found in KG_3 green gram fortified kodo papad. Data showed that incorporation of soybean (at 10%), and sago enhance the energy value of formulated papad. This might be due to supplementation of protein, fat and carbohydrate rich flours. Similar findings have been supported by Veena *et al.* (2012) incorporation of soy flour on the quality of papad.

5.5 Minerals

It is obvious from the tables that incorporation of nutritious flours had different effect on the minerals content of fortified papad.

5.5.1 Calcium

Calcium content of fortified papad was observed in table and fig. Highest calcium content was found in KSO_2 kodo based soy fortified papad whereas, minimum was found in KuS_3 kutki based sago fortified papad. Showed that the supplementation of green gram and soybean flour increased the calcium content in all papad. This might be due to rich source of calcium in those flours. Similar findings have been reported by Vidyavati *et al.* (2004).

5.5.2 Phosphorus

The data presented in table revealed that maximum phosphorus content was noted in $KuSO_2$, whereas, minimum was found in KuS_3. As evident from table that phosphorus content increased with the supplementation of soy and green gram flour in all fortified papad. These result are closed by Visalakshi and Mohansundari (2002).

5.5.3 Iron

Maximum iron content was found in $KuSO_2$, whereas minimum was found in without pulses supplemented fortified papad. Supplementation of soy flours had increased the iron content in fortified papad. This might be due to the incorporation of rich source of iron content flours. Similar findings have been obtained by Reema *et al.* (2004).

5.6 Storage study

The storage of the best fortified papad was selected from kodo and kutki based fortified papad. Papad were packed in low density polyethylene bags, plastic boxes and steel boxes kept at regular intervals for 0, 1, 2, 3, 4, 5 and 6 months at ambient condition.

Overall acceptability

The overall acceptability of fortified papad was significantly affected by different processing variables and declined with increase of storage period. The highest mean scores for overall acceptability of fortified papad was found in rice supplemented papad in all packaging material at initial stage of storage. The minimum mean score value was recorded in soybean supplemented papad in all packaging materials after 180 days of storage. The overall acceptability of fortified papad stored in steel box had better results as compared to low density polyethylene bags and plastic box. The higher values in polyethylene bags might be due to high moisture absorption and permeability of atmospheric gases involved in reduction of colour and flavour. The papad stored in steel box had slightly higher values of sensory attributes compare to the products in plastic box and LDPE bags. This finding in agreement with the result of Khanam *et al.* (2011).

Moisture content

The tables showed that the moisture content slightly increased with increasing during storage period in all formulated fortified papad in all type of packaging materials. Soy supplemented papad store in polyethylene bags showed higher moisture content followed by plastic and steel boxes. Moisture content of other formulated papad showed slight decreased in samples in all the packaging materials during storage. It can be attributed to greater protection against water vapour, though polyethylene bags seem to be comparatively more permeable to water vapour. A similar finding was reported by Veena *et al.* (2012) incorporation of soy flour on the quality of papad.

Free fatty acid

During storage there was a gradually increase in the fatty acid in all formulated fortified papad. The values of free fatty acid were not found in all packaging materials upto 120 days storage. After 120 days there was a free fatty acid in all packaging materials except P_1KS_2 fortified papad. This indicated that all packaging materials could be considered the safest in fortified papad for free fatty acid content. Maximum free fatty acids was found in $KuSO_2$ formulated fortified papad 180 days of storage while minimum was found in P_2KS_2 and P_2KuS_3 fortified papad in low density after 180 days of storage. This might be due to supplementation of high content of fat flours in formulated papad. Similar finding have been supported by Veena *et al.* (2012).

CHAPTER – 6

SUMMARY, CONCLUSIONS AND SUGGESTIONS FOR FURTHER WORK

SUMMARY, CONCLUSION RECOMMENDATION AND SUGGESTION FOR FURTHER WORK

Summary

Minor millet fortified papad is a rich source of protein, fibers, minerals and highly energetic snacks consumed and liked by everyone. Therefore the present study was made on Process Standardization and Quality Evaluation of Millet fortified Papad. The obtained results on various parameters like overall acceptability and nutritional attributes have been made and summarized in the following points.

- Kodo based rice fortified papad KR_3 (kodo:rice) at the ratio 40 : 60 was the best formulated fortified papad, rich in nutrients and had excellent overall acceptability.
- Sago fortified kodo based papad KS_2 (kodo:sago) at the ratio 60 :40 had good results for colour, flavor, texture, taste and overall accepatability.
- Fortification of 10% Soy flour and 15% green gram flour in minor millet based formulated fortified papad (KSO_2, KG_3, KuG_2 and $KuSO_2$) could be recommended to increase and improve the biological value of protein and other nutrients such as calcium and phosphorus.
- Kutki based rice fortified papad at the ratio of 20:80 have highest overall acceptability as compared to other formulated papad.
- During storage steel boxes was found to be the best as compared plastic boxes and LDPE bags for maintaining the good quality products under the period of 180 days.

- The fortification of soybean upto 10% limit in kodo and kutki based papad (KSO_2 and $KuSO_2$) had more nutritious value than other fortified papad.

- Shelf life of the KS_2 and KuS_3 fortified papad (kodo+sago 60:40 and kutki+sago 40:60) were found to be the best in all packaging materials for the period of six months of storage at ambient condition.

Conclusion

On the basis of findings it was concluded that soy fortified papad could be consider the best from nutritional point of view, whereas overall acceptability point of view rice fortified papad could consider the best. Fortification of soy and green gram flours increased the amount of fibers, calcium, phosphorus and iron in fortified papad. It concluded that steel and plastic boxes could be used as a better storage material for fortified millet papad at domestic level. Hence it was concluded that low cost high protein energy fortified papad could be developed. Efforts should also be made to suggestion for transfer this technique to house hold women for cottage level. It is, therefore, recommended that inclusion of such papad in supplementary feeding programmes like ICDS would certainly help in improving the nutritional status of masses.

Suggestions for further work

Although the present investigation has given many useful information on various aspects of "papad making" and also fortification in the minor millet based papad. Yet some more work should be carried out on the following aspects.

- Techno-economic feasibility of fortified papad should be evaluated.

- Assessed for micronutrient availability, dietary fiber content, invitro starch digestibility, invitro protein as well as carbohydrate digestibility should be studied.

- Assessment of microbial load at various stages of processing and storage should be evaluated.

- Nutritional quality evaluation of the processed product through feeding trials on rats in order to assess PER, BV, NPU and other related haematological and histopathological changes.

REFERENCES

REFERENCES

A.O.A.C (1995). Official methods of analysis. 16th Edn. Association of Official Analytical Chemists. Washington DC

A.O.A.C. (1984). Official and tentative method of analysis. Assoc. Official Agri. Chem. 9th Ed Washington D.C.

Ahamed Thoufeek N., Rekha Singhal, Pushpa R. Kulkarni and Mohinder Pal, (1997). Deep fat fried snacks from blends of soya flour and corn, amaranth and chenopodium starches. *Food chemistry*. 58:4, 313-317.

Amerine, M.A., Pangborn, R.M., and Rosseier, E.B., (1965). Principle of sensory evaluation of food. Academic press, London.

Amudha Senthil, R. Ravi, K.K. Bhat and M.K. Seethalakshmi (2002), Studies on the quality of fried snacks based on blends of wheat flour and soya flour. *Food Quality And Preference*. 13(5) : 267-273.

Balasubramanium S. and Vishwanathan R., (2010). Influence of moisture content on physical properties of minor millets. *J. Food Sci. Technol.*, 47(3) : 279-284.

Berwal J.S., J.S. Dhanda and R.K. Berwal. (1996). Studies on rice and turkey meat blend papads. *J. Food Sci. Technol.* 33(3) : 237-239.

Beuchat, L.R., Cherry J.P. and Michael, R. (1975), Physico-chemical properties of peanut flour as affected by proteolysis, *J. Agric. Food Chem*. 23 : 616.

Bhattacharya S. and H.V. Narsimha, (1999), Characterization of pap ad from different blends of cereals with blackgram. *J. Food Quality*. 22(2) : 157-166.

Chansoriya I. and L.P.S. Rajput, (2005), Effect of papad khar and water on the quality characteristics of soy blended papad. *J. of Dairying Fd. & Home Sci.* 24:2

Chaudhary M.N., M.V. Rajgopal, Smita P. Roy and Sumati R. Mudambi, (1984). Effect of incorporating papad khar (crude sodium carbonate) in papad dough on the physico-chemical properties of the frying medium. *J. Food Sci. Technol.* 22 : 119-122.

Chauhan, G.S. and Tomar, N.S. (1998). Varietal effect on the quality of fried snacks. *J. Fd. Sci. Technol.* 35 : 171.

Chauhan, S.K., Tyagi, S.M. and Chauhan, G.S. (1998). Effect of various preservatives on shelf life of tofu. *J. Fd. Sci. Technol.* 35 : 72.

Chowdhury M.G.F., Miaruddin M., Rahman M.M., Islam M.S. and Tariqul Islam A.F.M. (2009), Study on the effect of preservative on the storage quality of spiced papads. *J. Innov. Dev. Strategy*, 3(1) : 30-33.

Das K. Himadri, (1992). Crisp and Spicy Snack. *J. Food Sci. Technol.*, 29(4) : 387-389.

Deepa, C.R., Asna Urooj and Shashikala Puttaraj, (1992), Effect of addition of soy flour on the quality characteristics of blackgram (*Phaseolus mungo* L.) papads. *J. Fd. Sci. Technol.*, 29(6) : 385-387.

Dev, D. K. and Mukherjee, K. D. (1986). Functional properties of rapeseed protein products with varying phytic acid content. *J. Agric. Food Chem.* 34:775.

Dhawan and Simmi (1998) Studies on incorporation of defatted soya flour and rice flour in sev preparation. M. Sc. Ag. Thesis (unpublished), G. B. Pant Univ. of Agric. and Tech. Pantnagar, India.

Diwakar, P., Kushwah, A. and Kushwah, H.S. (1996). Effect of processing on the functional properties of some local varieties of horse gram (*Dolichus biflorus* L.) in Madhya Pradesh. *J. Fd. Sci. Technol.*, 33:150.

Garg, R. and Dahiya, S. (2003), Nutritional Evaluation and Shelf Life of Papads Prepared from Wheat-Legume Composite Flours. *Plants Foods for Human Nutrition*, 58(4) : 299-307.

Gopalan, C., Ramasastri, B.V. and Balasubramaniam, S.C. (1980) Nutritive value of Indian foods. I.C.M.R Hyderabad, India.

Gopalan, C., Ramasastri, B.V. and Balasubramaniam, S.C., (1996). Nutritive value of Indian foods. National institute of nutrition, Indian Council of Medical Research, Hyderabad, India.

Grahm, D.E. and Phillips, M.C. (1976), In: foam akers, R.J (Ed.). Academic Press, New York, P. 237.

Hossain, M.E., Sultana, S., Shahriar, S.M.S. and Khatun, M.M. (2012), Ntritive value of rice. *Online J. of Animal and Feed Res.* 2(3) : 235-239.

Johnson, D. W. (1970), Functional properties of oil seed protein. *J. Am Oil Chem. Soc.*, 47:402.

Ke shun lio, (1997), Chemistry and nutrition value of soybean components. *Soybeans*. 25-113.

Khanam, A., Kumkum, R. and Swamylingappa, B. (2011). Functional and nutritional evaluation of supplementary food formulation. *J. Food Sci. Tech.* Online.

Kinsella, J.E. (1979). Functional properties of soy protein. *J.AM. Oil Chem. Soc.* 56 : 242-258.

Kulkarni S.G, J.K. Manan, Kishorilal, M.D. Agrawal and I.C. Shukla, (1996). Physico-chemical characteristics of commercial spiced papads. *J. Food Sci. Technol.* 33(5) : 418-420.

Kulkarni, S. G., Saxena, A. K., Mannan, J. K. and Berry, S. K. (1989). Studies on packaging and storage of North Indian spiced papads made from blends of different dhals (split pulses). *J. Fd. Sci. Technol.*, 26 : 121.

Lin, M.J., Humbert, E.S. and Sosulski, F.W. (1976). Certain functional properties of sunflower meal products. *J. Fd. Sci.* 39:368.

Mamatha and Jamuna Prakash, (1995), Quality attributes of papads incorporating different levels of rice bran. *J Food Quality*, 18(3) : 215-233.

Millets Future of Food and Farming, (2008), B-45, Maheswari Towers, Road No. 1, Banjara Hills, Hyderabad, 500-034.

Narayan, K. and Narsingarao, M. S. (1982). Functional properties of raw and heat processed winged bean flour. *J. Food Sci.*, 47:1534.

Narayana, K. and Narsinga Rao, M.S. (1982). Functional properties of raw and heat processed winged bean flour. *J. Fd. Sci.* 47 : 1534.

Neelima A. and Sarojini G. (1991). Quality of extracted oil from some commercially sold deep fat fried snacks and used oil. *J. Food Sci. Technol.*, 28(2) : 108-109.

Patil, V.D. and Makne, V.G. (1978). Approximate content of four amino acids in some cereals and protein sources. *Oilseeds J.* 3 : 17.

Paul Tapash, Rubel Mazumder, N.H.M., Sayed, M.A. and Akhtaruzzaman, M. (2011), Proximate compositions, mineral contents and determination of protease activity from green gram (*Vigna radiata* I. Wilczek). *Bang. Res. Publi. J.* 5(3) : 207-213.

Pawar V.D., Machewad, G.M., Durge, A.V. and Maitre, A.S. (2009). Processing and characteristics of snacks extruded from rice and corn grits and two malted legumes. *J. Food Sci. Technol.* 46(5) : 494-496.

Pawar, V.D. and Ingle, U. M. (1988). Production of quick cooking mothbean III. Effect of soaking on activity of trypsin inhibitor. *Indian J. Nutr. Dietet.* 24:376.

Pruthi, J.S., Kalra, C.L., Manan, J.R. and Raina, B.L., (1982). Manufacture, packing and storage of north Indian spiced *papads. Indian Food Pack.*, pp.43-49.

Pruthi, J.S., Manan, J.R., Kalra, C.L. and Raina, B.L., (1984). Variability in the physico-chemical characteristics of spiced *papads* of Punjab. *J. Food Sci. Tech.,* 21: 299301.

Rahman M.M. and M.B. Uddin, (2008). Chemical analysis and shelf life studies of papads prepared from legume flours. *Int. J. Sustain. Crop Prod.* 3(1) : 7-12.

Rahman M.M. and M.B. Uddin, (2008). Effect of frying condition on moisture and fat of papads. *Int. J. Sustain. Crop Prod.* 3(2) : 16-21.

Reema, C.K. Hira and Balwinder Sadana (2004). Nutritional Evaluation of Supplementary Food Prepared From Germinated Cereals and Legumes. *J. Food Sci. Technol.*, 41(6) : 627-629.

Saxena, A.K., Kulkarni S.G., Manan J.K. and Berry S.K. (1989), Studies on the blends of different pulses (Bengal gram, green gram, lentils and arhar) in preparation of North Indian spiced papad. *J. Fd. Sci. Technol.* 26(3) : 133-136.

Singh, N., Usha Bajwa and K.S. Sekhon (1996). Pasting and papad quality of rice, wheat and mung flour blends. *J. Food Sci. Technol.* 33(3) : 224-228.

Sood, D.R., Wagle, D.S., Nainawatee, N.S. and Gupta, Y.P. (1977). Varietal differences in the chemical composition of soybean. *J. Fd. Sci. Technol.* 14 : 177.

Sosulski, F.W., Humbert, E.S. Bui, K. and Jones, J.D. (1976). *J. Food Sci.* 41:134.

Surpalekar, S.R., Venkatesh, K.V.L., Prabhkar, J.V. and Amla, B.L., (1970). Physic-chemical characteristics and quality assessment of commercial papads. *J. Food Sci. Technol.* 7 : 100-105.

Tasneem, R.; Ramamani, S. and Subramanian, N. (1982). Functional properties of guar seed meal detoxified by different methods. *J. Fd. Sci. Technol.*, 47:1175.

Veena B., B.S. Reddy and Sunand Sharan. (2012). Effect of incorporation of soy flour on the quality of papad. *J. of Bio., Agri. And Healthcare.* 2(5) : 119-126.

Velu V., K. Balaswamy, A. Nagender and D.G. Rao, (2004), Effect of various ingredients and additives on papads. *Food service Research International.* 15(2) : 78-88.

Vidyavati, H.G., Begum, M.J. Vijayakumari, Sumangla, S. G. and Shamshad Begum, (2004). Utilization of finger millet in the preparation of papad. *J. Food Sci. Technol.* 41(4) : 379-382.

Vijayakumari T. Poongodi and Jemina Beryl Mohankumar (2009), Formulation and characterization of *Millet* flour blend incorporated composite flour. *International J. of Agri. Sci.*, 1(2) : 46-54.

Visalakshi and Mohanasundari (2002). Incorporation of whey protein concentrate in maida based snacks and TTS consumer acceptability. *Indian J. Nutri. Diet.*, 39 : 333.

Wang, J.C., and Kinsella, J.E. (1976). Functional properties of novel protein: Alfalfa leaf protein. *J. Food Sci.*, 41: 286-292.

Wu, Y. V. and Ingett, G.R., (1974). Denaturation of plant proteins related to functionally and food application. *J. Fd. Sci. Technol.* 59:218.

VITA

VITA

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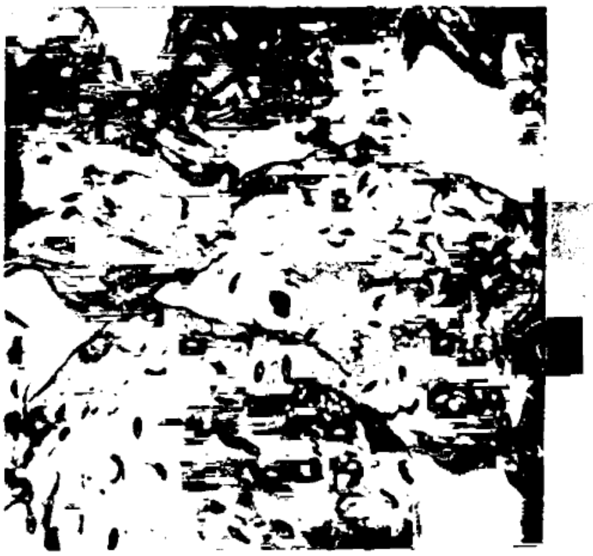
KR 3



KS 2

KG 3

KSO2

Plate No 3 - Kodo based fortified papad.