# CONVENTIONAL NUTRIENTS AND ANTIOXIDANTS IN RED KIDNEY BEANS (*Phaseolus vulgaris l.*): AN EXPLORATIVE AND PRODUCT DEVELOPMENT ENDEAVOUR

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***Abstract***
*Micronutrient deficiencies can easily develop during different physiological states and illnesses or becomes worse when they are already present. Most of these people living in low income countries are typically deficient in more than one micronutrient. Proximate, mineral composition, antioxidant and antinutrients of raw and processed red kidney beans (RKB; botanical name: Phaseolus vulgaris l.) were investigated on dry weight basis with a view to find alternative and cheaper sources of protein, calcium and iron to solve the problem of malnutrition due to inadequate protein, iron and calcium in diet, which is commonly prevalent in developing world. Processing methods, hot water blanching [HWB], was adopted using its household adapted version. RKB was processed by HWB (at about 95°C) and milled into flour by using a grinder. Quantization of proximate principles showed that they were good sources of protein, rich in fiber, iron and calcium also. Evaluation of the antioxidant and anti-nutritional properties of kidney beans showed that blanching reduced phenol content (whole- 5.19± 1.12mg/100g and blanched- 4.12±0.87 mg/100g); tannins (whole-4533±251mg/100g and blanched- 2833±602 mg/100g); phytic acid (whole- 543± 6.1mg/100g and blanched- 343±9.7 mg/100g); total cyanogens (whole-0.04±0.002 mg/100g and blanched-0.03±0.002 mg/100g) and trypsin inhibitors (whole-12.2±0.81U/g and blanched-12.0±0.79U/g) respectively. The findings suggest that processing methods- HWB applied to kidney beans could be more beneficial for enhancing the nutrient profiles and reducing the antinutrients for better absorption of nutrients.*

**Keywords:** RKB= Red kidney beans, HWB= Hot water blanching, RP=Rustic papdi, WRKB=Whole red kidney beans, BRKB= Blanched red kidney beans.

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## 1. INTRODUCTION

Lactation is the period of time that a mother lactates to feed her young. In the United States, by 2010, 75 percent of mothers will breastfeed their newborns in the early postpartum period, 50 percent will continue to breastfeed through their infants' first six months and 25 percent will breastfeed their babies throughout their first year of life (*Capuco AV et al, 2009*). Good and healthy nutrition is essential during lactation period because of relatively greater need for vital nutrients and are more susceptible to the harmful consequences of deficiencies. Lactating women should be encouraged to obtain their nutrients though a well-balanced diet, which is based mainly on plant foods that helps to stay healthy and energetic. Therefore it is important to eat lots of pulses, beans and lentils. Red Kidney Beans (*Phaseolus vulgaris l.)* have greatest popularity in the U.S. as well as play long been a part of traditional plant based diet in many cultures of most of the world's developing countries (Shimelis and Rakshit, 2007). It is the most important economic variety of the genus *Phaseolus;* scientifically known as *Phaseolus vulgaris* (Common Beans) and also referred as *Rajmah, Bakla in Hindi; Haricot bean in English, Haricot commun in French* (Uebersax, 2006). It is dicotyledonous herbaceous annual plant of the family leguminosae. It is estimated by Wang et al. (2009) that red kidney beans have 21.5-27.1% protein, 1.1-1.2% fat, 61.7% carbohydrates (36.1% starch), 7.0%- 20% fiber, 3.0- 4.4% ash lies in their composition**.**

They have been associated with numerous other health benefits including reduction of heart (Bazzano, 2001) and renal diseases risks, cataracts, relieve constipation, improve gastrointestinal integrity, stabilize blood sugar, brain and immune dysfunction (Bourdon, 2001).

As a matter of fact, beans are an often overlooked source of incredible medicinal benefits since Vedic era and have different parts of plants are used in general medicinal applications.

The effectiveness of beans in the treatment of rheumatism, intractable coughs, acne, eczema, eruptions and arthritis plus disorders of the urinary tract. Besides having all these therapeutic properties, beans have relatively high concentration of potentially toxic substances such as phytate, tannins and oxalate that can cause food poisoning referred to anti-nutritive factors affects the nutritional quality by interacting with intestinal tract and also reduce protein digestibility.

These components can be reduced or inactivated through the application of a variety of processing techniques such as- germination reduces trypsin inhibitors (N. EL-HAG and R.E. Morse, 2000); dehulling and soaking reduces tannin content; cooking decreases the phytic acid (Zia-ur Rehman and W.H. Shah, 2005) that are earmarked which improves the nutritive value and biological availability of legumes and exert adverse physiological effects when ingested by man and animals.

Hot-water blanching is a common process applied for nuts and seeds, to enhance their sensorial properties and nutritional value. Soaking to hydrate the beans prior to heating, therefore, is a very important step to effectively inactivate or reduce the levels of inhibitors such as- trypsin inhibitors and lectins and phytic acid and increase the content of catechins and polyphenols**..**

Therefore, the work was aimed to determine proximate, antioxidant and antinutrients of raw and processed red kidney beans (RKB) to make use of treasure trove of nutrients in food product development.

## 2. MATERIAL AND METHODS

In the present study, *Phaseolus* species of red kidney beans (*RSJ-178*) was selected on the basis of its wide cultivation and consumption in India. It was procured from authentic source, such as- Rajasthan Seed Corporation, Jaipur after due certification. After purchasing the beans, preliminary preparation like- cleaning was done and seeds freed from any dirt or foreign matter. For optimizing nutrient yield and removal of antinutrients, raw kidney beans were processed by using household adaptable strategy such as- hot water blanching (HWB). Analysis for proximate principles and some minerals- iron, calcium and phosphorus were performed on raw and processed state of variety in triplicate sets. All chemicals used in the study were of analytical grade, procured from credible concerns e.g. Merck, Loba. Chemicals of higher purity and of scarce availability.

### Processing techniques

Procured kidney beans were thoroughly cleaned, fried from dirt and foreign matter. Thereafter, they were graded and whole seeds were kept separately for analysis and the rest discarded. Then, the beans were divided into two portions. One portion of the beans was ground to a fine powder or flour and the other portion of beans were processed by giving the following treatments.

### Hot-water blanching:

Another portion of beans were taken and soaked separately in boiled distilled water at 95°C into the ratio of 1:5w/v for ½ hour in beaker**.** Mixed with spoon to 2-3 times and left for 30 minutes. After half an hour, the water was decanted. Then, beans were washed with fresh water and soaked overnight at room temperature. Next day, water was drained and beans were dehulled manually and dried in direct sunlight properly so as to make them moisture free. Then, dried beans were ground into powdered form and stored in air tight containers. Flour of kidney beans was subjected to further treatment and analysis.

**Proximate analysis**

The proximate and nutritional parameters evaluated were moisture, crude protein, fat, fiber, ash, carbohydrate, calcium, iron and phosphorous (Raghuramulu et al., 2003; AOAC, 2005; Sharma, 2007). All were analyzed in triplicate sets. Moisture content was determined by drying up the sample in air oven at 100-125°C. Crude protein was carried out using the Kjeldhal procedure with nitrogen to protein factor of 6.25. Fat was estimated through soxhlet extraction. Fiber was analyzed through its resistance to the action of dilute mineral acid (Sulphuric acid) and alkali (Sodium hydroxide). Carbohydrate was calculated by subtracting from 100, a sum of values (g/100g) for moisture, protein, fat, ash and crude fibre. Calcium, iron and phosphorus were estimated by dry ashing method.

**Antioxidant**

**Determination of phenol content**

Phenol content was determined by Single and Slinkard (1977). The finely grounded sample (2g) was extracted with 5-10ml of 80% alcohol in a pestle mortar and the homogenate was boiled in water bath for 5-10 mins, centrifuged and supernatant was collected in the same flask and volume made up. Samples (200 ml) were introduced into test tubes, and then 1.0 ml of Folin-Ciocalteau's reagent and 0.8 ml of sodium carbonate (7.5%) were added. The absorbance of all samples was measured at 760nm after incubating at 30°C for 1.5 hrs. Result was expressed as milligm of gallic acid equivalent (GAE) as per gram of fresh weight of sample. Standard curve was drawn by plotting the absorbance against concentration of gallic acid.

**Determination of tannins content**

Tannin was determined by Price *et al* (1978). 1gm of sample was extracted with 10ml of 1% HCl in methanol for 24 hours at room temperature then centrifuged at 5,000 rpm. Vanillin HCl reagent was prepared by mixing prior to use equal volumes of 8% HCl in methanol with 2% vanillin in methanol. One ml of supernatant was mixed with 5ml of Vanillin-HCl reagent. Catechin standard was run along with the sample. The absorbance was read at 500nm after 20 minutes incubation at room temperature.

**Determination of phytic acid**

Phytic acid was determined by Davies and Reid (1979). One gram of dried powdered sample was taken and extracted with 3% TCA by continuous shaking, filtered and made up to suitable volume with water. To 1.4ml of the filtrate, 1ml of ferric ammonium sulfate solution (21.6mg in 100 ml water) was added, mixed and placed in a boiling water bath for 20 minutes. The contents were cooled and 5ml of isoamyl alcohol was added and mixed. To this, 0.1ml ammonia solution was added, shaken thoroughly and centrifuged at 3,000 rpm for 10 minutes. The alcoholic layer was separated and color intensity was read at 465nm against amyl alcohol blank after 15 minutes. Standard Fe $(NO_3)^3$ was run along with the sample. Graph of standard was plotted and results were expressed as mg phytic acid/100g of dry weight.

**Determination of total cyanogens**

Total Cyanogens were determined by Vogel (1996). 5 g of sample was taken in a glass stoppered flask and 50ml of 1% HCL-methanol was added. It was stoppered and kept overnight. After filtration, 25ml of extract were taken in a conical flask and 75ml of distilled water was added. Then 5ml of ammonium chloride was added, and lastly, 2ml of 10% potassium iodide solution was added in a flask. The flask was kept on a sheet of black paper and titrated with standard 0.002M silver nitrate solution. When one drop gave permanent turbidity, end point was reached.

**Determination of trypsin inhibitor activity**

Trypsin inhibitor activity was determined by Kakade (1969). 0.2 to 1.0 ml of aliquot, trypsin solution (0.05mg/ml in 0.001M HCl) were pipetted into separate triplicate set of test tubes and final volume adjusted to 1 ml and 2 ml with phosphate buffer (0.1M, pH 7.6) for aliquot and trypsin solution respectively. 1 ml of trypsin solution, added to aliquot tubes and all the tubes kept at water bath at 37°C. In one of the triplicate tubes of aliquot and trypsin solution, 6 ml of 5%TCA was added, marked as blank and in others, 2ml of 2% casein solution added and then kept at 37°C for exactly 20 minutes. 6 ml of 5% TCA was added and absorbance was measured at 280nm after 1hour against blank using a UV visible Elico spectrophotometer. Plot the absorbance against the volume of extract. One trypsin unit (TU) is defines as an increase of 0.01 absorbance units at 280nm in 20 minutes per 10 ml of the reaction mixture. Trypsin inhibitor activity is defined as the number of trypsin unit inhibited (TIU).

**Product development**

Conventional recipe, namely-***Rustic Papdi*** (RKB-20%) was developed by using the raw and processed form of beans. In the developed countries, papdi are extensively used and prepared at household level for providing optimum nutrition. The following recipe was selected on the basis of popularity as well as on the basis of its potential for providing optimum nutrition, and health promotion. Standard (S) of *rustic papdi* was prepared using refined wheat flour (30g), semolina (20g), gingelly seeds (10g) and sugar (20g) only. Refined oil (20ml) was used for deep frying. Test samples of recipe were prepared with incorporation at 10% level of RKB in raw (A) and processed form (B) both. Composition of recipe is given in table-1.

**Organoleptic evaluation**

First of all, triangle test was applied to select semi trained panel for performing sensory evaluation. Finally, the products prepared were evaluated for acceptability at a nine point hedonic method by 15 semi trained panel members. Hedonic rating relates to pleasurable and unpleasurable experiences and the acceptability is judged for the reactions of the panelists in terms of their depth of liking or disliking of the given product. All samples were served to the panel members in session. They were then asked to rate the acceptability of the product on a scale, usually of points, ranging from 'like extremely' to 'dislike extremely'.

**Statistical analysis**

Data obtained was subjected to the analysis of mean, standard deviation and t-test.

**Table 1: Incorporation of Red Kidney Beans (RKB) in whole (WRKB) and processed (BRKB) powder forms with other Ingredients in Rustic Papdi**

| Ingredients | Standard (g/100g) | Variant (A) (g/100g) | Variant (B) (g/100g) |
|---|---|---|---|
| **Refined wheat flour** | 30 | 20 | 20 |
| **Semolina** | 20 | 20 | 20 |
| **WRKB** | - | 10 | - |
| **BRKB** | - | - | 10 |
| **Gingelly seeds** | 10 | 10 | 10 |
| **Sugar** | 20 | 20 | 20 |
| **Refined oil** | 20 | 20 | 20 |
| **Total** | 100 | 100 | 100 |

**Table 2: Mean values of proximate principles of whole red kidney beans (WRKB) and blanched red kidney beans powder (BRKB)**

| Samples→ Proximate principles ↓ | WRKB | BRKB |
|---|---|---|
| **Moisture (g/100g)** | 12.3 ±0.43 | $13.2\pm0.36^{s}$ |
| **Ash (g/100g)** | 3.6±0.36 | $3.2\pm0.79^{s}$ |
| **Protein (g/100g)** | 23.63 ±1.18 | $21.7\pm1.50^{s}$ |
| **Fat (g/100g)** | 1.5±0.2 | $1.3\pm0.1^{ns}$ |
| **Fiber (g/100g)** | 4.0±0.34 | $3.6\pm0.38^{s}$ |
| **Carbohydrates (g/100g)** | 56.7 ±3.61 | $62.7\pm5.0^{s}$ |

## 3. RESULTS AND DISCUSSION

### Nutrient analysis

Moisture content of raw sample of red kidney beans was found to be 12.3±0.43 g/100g. The results indicated that moisture content increased significantly in blanched sample with values to 13.2±0.36 g/100g for RKB. In other studies moisture content of raw sample of kidney bean variety was found to be in the range of 10.1-12.7g/100g (Khatoon and prakash, 2004). It was found that the higher level of moisture content in blanched beans vis-à-vis raw kidney beans is due to blanching treatment involving water. This increase in moisture content is related to augmented water content during overnight soaking due to hydrolytic enzymes (Osman, 2007). Ash content in raw sample of kidney beans i.e. RKB was 3.6±0.36g/100g respectively. After processing, the ash content decreased significantly in blanched sample of the variety to 3.2±0.79 g/100g for RKB. Many authors (Bhagya et al., 2007) also supported similar results which can be correlated with present many other workers (Beleia et al., 1993). The reduction in fiber content during processing may be due to the removal of the seed hull. Since legumes are good source of protein and, in the same vein, kidney beans protein content stood at 23.6±1.18g/100g in raw sample for RKB. Even after blanching, the difference in the protein content of the variety became negligibly small, standing at 21.7±1.50g/100g for RKB. The similar observation was reported by other studies with a range of 20.9-26.9g/100g (Ofuya and Akhidue, 2005).

The reduction in protein content after processing could be attributed to the hydrolysis of protein into simpler compounds or leaching of soluble proteins into soaking water (Sharma et al., 2002). It was found that carbohydrate content of raw sample of RKB was 56.7±3.61g/100g, while after blanching, the same increased significantly in kidney bean variety, to 62.7±5.0g/100g. The values of carbohydrate content of kidney beans was found to be similar when compared to different varieties of sesbania seeds and jack findings. Processing treatment i.e. blanching is reported to decrease the ash content insignificantly may be due to the leaching out of both macro and micro elements into soaking water. A similar result was reported by another study (Kazanas and Fields, 1981). Fat content of raw RKB was 1.5±0.2 g/100g respectively. The results registered insignificant variation in the values of fat content of 1.3±0.1g/100g in the variety after blanching treatment. The decrease in fat content in soaked-blanched beans vis-à-vis raw ones can be corroborated with the findings to other workers (Ramakrishna et al., 2006). The reduction of fat content was probably due to break-down of the triglyceride into simple form due to high lipolytic enzyme activity during processing (Idouraine et al., 1980). Fat content of the kidney bean variety is small making these beans a foodstuff with positive nutritional implications. Fiber content of raw RKB was 4.0±0.34 g/100g respectively and after blanching treatment it was found to be decreased significantly to 3.6±0.38g/100g for RKB. Similar results were reported by beans (Hossain and Becker, 2001) but the values are higher than those of soybean (26.3%) and cranberry beans (31.5%) and lower than lima bean (66.9%) and pigeon pea (66.8%) reported by (Aremu et al., 2006). The carbohydrate content of the red variety of beans showed that the kidney beans could become good supplement to scarce cereal grains as a source of energy and for feed formulations. (Table-2)

Its total ash content encompasses minerals of considerable nutritional importance. It was found that calcium content of raw sample of RKB was 221±58.28 mg/100g. Mineral analyses of processed forms of kidney bean variety revealed that calcium content increased significantly to 235.6±55.51mg/100g in RKB. The similar findings was obtained by Ghavidel and Prakash (2007) and Sandberg (2007), who reported that calcium content was found to 220 mg/100 g in dry matter of kidney beans. But the contradictory observations was stated by Sangronis and Machado (2007).

**Table 3: Mean values of minerals in whole red kidney beans (WRKB) and blanched red kidney beans (BRKB)**

| Samples→ Minerals ↓ | WRKB | BRKB |
|---|---|---|
| Iron (mg/100g) | 5.3±0.31 | 6.0±0.1 [s] |
| Calcium (mg/100g) | 221±58.28 | 235.6±55.51[s] |
| Phosphorus (mg/100g) | 408 ±4.35 | 415±5.29[s] |

Iron content of raw sample of RKB was 5.3±0.31mg/100g. After the application of processing treatments, the iron content was found to be increased significantly in RKB to 6.0±0.1mg/100g. The results showed that phosphorus content of raw RKB was 408±4.35 mg/100g.
After processing, the phosphorus content of the blanched sample stood at 415±5.29mg/100g for RKB. The data showed that the phosphorus content in the variety of kidney beans was increased significantly after blanching treatment. They have higher phosphorus content comparatively than other legume seeds (Aremu et. al., 2008, 2010). The results indicated that the values for mineral content increased possibly due to the fact thus the outer covering that got removed in the processing action might have been low in mineral content. The kidney bean variety could become good source for providing calcium and iron and helpful in overcome nutritional deficiencies of calcium and iron. Results revealed that *rustic papdi* fortified with 10% KBF showed the possibility of incorporation of beans into food products at both household and commercial level. (Table-3).

**Effect of processing on antioxidant and antinutritional factors**

The results of processing treatments on antinutrient and antioxidant of unprocessed and processed kidney beans are depicted in table-4. Antioxidant analysis of kidney beans revealed that phenol content in raw RKB stood at 5.19±1.12 mg/100g which is similar to the values reported by various studies (Yasmin et al., 2008). On blanching, it was seen that phenol content was decreased significantly in RKB to 4.12±0.87mg/100g. This decrease in phenols could result from the activation of polyphenol oxidase enzyme resulting in degradation and consequent losses of polyphenols during soaking prior to dehulling (Khandelwal et al., 2010). Bean hulls contained a large amount of phenolic compounds that exhibited strong antioxidant and antimutagenic activity. The total phenolic content of whole and dehulled beans ranged from 2.2-78.2 & 0.6-6.3 mg of catechin equivalent per gm of sample respectively, which significantly decreased with all processing methods. During dehulling, 60-70% of polyphenols was decreased (Ma Yu & Bliss, 1978). The phenol content was higher in dark colored beans as compared to light colored beans. Rehman and Shah, 1996; reported a significant reduction in the polyphenol contents of different legumes with various soaking processes. The physiological effects of dry bean consumption may be due to the presence of abundant phytochemicals includes polyphenolics, which possess both anti-carcinogenic (Aaby et. al, 2004) and antioxidant properties (Dos Santos et. al, 2006) and anti-inflammatory properties which decrease the incidence of several degenerative diseases- coronary diseases and remove carcinogens from the body (Kris-Etherto and others, 2002). Epidemiological studies have indicated that regular consumption of foods rich in **phenolic compounds** such as fruits, vegetables, whole grain cereals, red wine and tea, is associated with reduced risk of **cardiovascular diseases**, neuro-degenerative diseases and certain cancers ( Nilsson *et al.*, 2004). In various studies tannins content of raw kidney bean variety (RKB) was found to be in the range of 2000-4560 mg/100g. The processing treatments (hot-water blanching) significantly decreased the tannin content of kidney bean variety may be due to the physical removal of seed coat of beans because most of the tannins are located in the testa of seeds (Reddy and Pierson, 1994). Similar findings were reported by Alonso et al., 2000; Boateng et al., 2008. Deshpande and Cheryan (1983) observed that the leaching losses during soaking of beans were highest for tannin among the antinutritional factors. Dehulling proved to be most effective processing method for reducing the tannin content in kidney beans. These results were in line with that of Rehman and Shah (2005) who stated that tannin content of black grams, red kidney beans and white kidney beans was significantly reduced after soaking and other processing treatments. As much as 60-70% reduction in the tannin content by dehulling after soaking and iron content will increased was reported by Akindahunsi (2004). Phytic acid of raw kidney bean variety (RKB) was found to be in the range of 330-550mg/100g which was similar with other studies (Rasha Mohamed et al., 2011; Ejigui, 2005). Phytic acid content decreased significantly during the blanching treatment. The results indicate that the reduction in the phytate content is due to their water- soluble property or leaching. This process also enhances the action of naturally occurring phytase in legumes (Shimelis and Rakshit, 2007). Soaking and dehulling of legumes in distilled water was an effective way of removing phytic acid from legumes (Liang et al., 2009). Similar reduction pattern was found in phytic acid during soaking, cooking and germination as reported by (Alonso et al., 2000) for chinese legumes, pea, faba pea, dry bean, lentil and black bean respectively. It has been reported that dehulled beans, particularly after soaking, was reduce phytic acid in *P. vulgaris* (Ibrahim et al., 2002). Akindahunsi (2004) concluded that the red kidney beans and pinto beans soaked in distilled water for 18 hrs at room temperature reduced their phytate content by 51.7 and 52.7 % respectively. Total cyanogens of raw kidney bean variety viz. RKB were found to be similar with that reported in the study of Yasmin et al., 2008. Cyanogen content has found to be insignificantly reduced during processing i.e. blanching of three kidney bean varieties. Regarding the kidney beans, similar results were found by Adeparusi (2001) who reported significant reduction in levels of cyanide to Lima beans (*Phaseolus lunatus*) after soaking treatments. The higher level of cyanide content in raw kidney beans was observed when compared to processed beans. Similar findings was reported by Akindahunsi (2004) that a value of 3.7mg/kg in raw African oil beans after soaking and cooking was reduced to 2.2mg/kg. Trypsin inhibitor activity of red kidney beans (RKB) was found to be in agreement with previous data reported by Mejia et al, 2005. The trypsin inhibitor activity was significantly reduced (P>0.05) by different treatment methods, hot water blanching being the most effective. Hot-water blanching significantly reduced the trypsin inhibitor activity in processed sample of kidney beans. Similar observations were reported by Osman (2007) in *Dolichos lablab* bean (*Lablab purpureus* (*L*) *Sweet*), chickpea, winged beans and Grewal and Jood (2006) in green gram dal. A similar reduction in trypsin inhibitor activity after soaking has been reported in cowpea, peas and kidney beans to 10.22–19.85% (Khattab et al., 2009). According to Ramakrishna et al. (2006), the raw Indian beans (*Dolichos lablab L.*) has a very high trypsin inhibitory activity which progressively decreases by 51% after the soaking for 12 hrs. Hot water blanching has been pin-pointed more effective in reducing the estimated antinutrients in this study than other processing treatments. It also enhances the utilization of nutrients along with increasing the bioavailability of minerals and improving the digestibility of proteins. (Table 4)

**Table 4: Mean values of antioxidant and antinutrients of Red Kidney Beans (RKB) in whole and processed forms**

| Antioxidant and Antinutrients | WRKB | BRKB |
|---|---|---|
| **Phenols (mg/100g)** | 5.19±1.12 | 4.12±0.87$^{s}$ |
| **Tannin (mg/100g)** | 4533±251 | 2833±602$^{s}$ |
| **Phytic acid (mg/100g)** | 543.0±6.1 | 343.0±9.7$^{s}$ |
| **Total cyanogens (mg/100g)** | 0.04±0.002 | 0.03 ±0.002 $^{ns}$ |
| **Trypsin inhibitor activity (U/g)*** | 12.2±0.81 | 12.0±0.79$^{s}$ |

*One unit (U) of the inhibitor activity was expressed as decrease by one unit of absorbance measured at 620nm in 20 min.

**Organoleptic analysis**

Three variants of *rustic papdi* were developed by incorporation of raw and blanched forms of kidney bean flour at 10%. From the scores of standard recipe and its variants for each attribute, it was clear that standard was most acceptable with an overall acceptability score of 8.6±0.48 and among all variants, VAR: B was most acceptable with an overall acceptability score of 8.2±0.67 and VAR: A was least acceptable with an overall acceptability score of 8.0±0.84. There was a no significant difference (P>0.05) between standard and VAR: B. In terms of appearance, VAR: B was highly accepted than standard and other variant. VAR: B was again best in terms of color. In terms of texture, standard and VAR: B2 both were equally accepted as compared to other variant. Taste wise, standard stood out again and among variants VAR: B had higher mean scores than VAR: A. In terms of flavor and after taste, VAR: B was most preferred by panel members but standard was still best among all. Acceptability evaluation scores of *rustic papdi* were shown in table-5.

The nutrient composition of developed recipe, *Rustic Papdi,* was also calculated as per compositional values given in the nutritive value of Indian foods by ICMR depicted in the following Table- 6. This nutritious recipe was proved to be good source of energy, protein, iron and calcium content during physiological state.

## 4. CONCLUSIONS

From the above observations, it can be concluded that Red Kidney Bean Flour (RKBF) is a good source of nutrients such as energy, protein, calcium, iron and phenol. This study indicated that different household processing methods such as- HWB affected the chemical composition of kidney beans by decreases the level of antinutritonal factors which are hindrance in nutrient absorption. *Rustic Papdi,* the recipe developed has been found to be a good source (per/100g) of energy (375.66 kcal), protein (9.83g), fat (10.8g), fiber (2.62g), iron (8.68mg) and calcium (177.55mg).

**Table 5: Mean scores of organoleptic evaluation of *Rustic Papdi***

| Attributes | S | Variant (A) | Variant (B) |
|---|---|---|---|
| **Appearance** | 8.2±0.80 | 7.9±0.79 | 8.4±0.96 |
| **Color** | 8.0±0.80 | 7.8±0.91 | 8.2±1.13 |
| **Texture** | 8.2±0.70 | 7.9±0.88 | 8.2±0.91 |
| **Taste** | 8.5±0.50 | 7.9±0.88 | 8.1±1.40 |
| **Flavor** | 8.6±0.48 | 7.9±1.30 | 7.9±1.29 |
| **After taste** | 8.5±0.50 | 7.9±1.35 | 8.0±1.12 |
| **Overall Acceptability** | 8.6±0.48 | 8.0±1.29 | 8.2±1.29 |

S = Standard Papdi, A = WRKB, B= BRKB

**Table: 6 Nutrient composition of *Rustic Papdi* prepared by incorporation of RKBF**

| **Ingredients** | **Nutrient Content per serving** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Rustic Papdi** | Energy (kcal) | Protein (g) | Fat (g) | Fibre (g) | Total CHO (g) | Calcium (mg) | Iron (mg) | Phosphorus (mg) |
| RWF (20g) | 69.6 | 2.2 | 0.18 | 0.06 | 14.78 | 4.6 | 0.54 | 24.2 |
| SL (20g) | 69.6 | 2.08 | 0.16 | 0.04 | 14.96 | 3.2 | 0.32 | 20.4 |
| S (20 g) | 79.6 | 0.02 | - | - | 19.88 | 2.4 | 0.03 | 0.2 |
| GS (10g) | 56.3 | 1.83 | 4.33 | 0.29 | 2.5 | 145 | 0.93 | 57.0 |
| RKBF (10g) | 34.6 | 2.29 | 0.13 | 0.48 | 6.06 | 26.0 | 0.51 | 41.0 |
| O (20g) | 180 | - | 20 | - | - | - | - | - |
| Total = 100g | **489.7** | **8.42** | **24.8** | **0.87** | **58.18** | **181.2** | **2.33** | **142.8** |

As per values according to Nutritive value of Indian foods given in ICMR. * Indian Dietetic Association (2006)
RWF = Refined Wheat Flour, SL = Semolina, S = Sugar, GS = Gingelly Seeds, RKBF = Red Kidney Bean Flour, O = Oil

The results of sensory evaluation revealed that VAR: B (7.00±0.96, prepared by incorporation of blanched red kidney bean flour has a better acceptability as compared to that of VAR: A (6.60±1.29, prepared by incorporation of raw red kidney beans flour) vis-à-vis the standard (8.00±1.13, without incorporation of raw red kidney bean flour and blanched red kidney bean flour).

The study points towards the fact that this healthy improvisation of *Rustic Papdi* due to fortification of *red kidney bean flour* could become helpful in fulfilling the nutrient requirements and holds a good potential for improving the nutritional status in various physiological conditions especially for nursing mothers.

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