# Comparative Evaluation of Major Nutritional Parameters for Eleven Pigmented Red Rice (PRR) and Nine Non Pigmented Rice (NPR), landraces of Assam. India

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***Abstract***

*The present study was undertaken to evaluate the major nutritive values of some indigenous land races of paddy from Assam, India. The study material comprise of 11pigmented red rice and 9 non pigmented rice. The Nutritional parameters studied were crude protein, total carbohydrate, lipid, crude fibre and total mineral in the form of ash content. The different fractions of carbohydrate were also studied viz- Total soluble sugar, starch, amylose, and amylopectin. Considerable variation was observed among and between PRR and NPR landraces. Among PRR crude protein content varied from 8.20% to 13.96% while corresponding range of NPR was 8.70% to 11.18%. Total carbohydrate for PRR varied from 64% to 80%. While the corresponding range for NPR varied from to 62% to 69%. Lipid content varied within the narrow range of 1.72% to 3.75% for PRR while the corresponding range of NPR was 2.17% to 3.46%. Total mineral in the form of Ash content also varied within a narrow range of 0.83% to 1.40% for PRR; while the corresponding range of NPR was 0.35% to 1.43% .Calorific values in case of PRR varies from 314.79 kcal to 379.19 kcal, while in NPR 314.06 kcal to 349.51 kcal .Carbohydrate fractionation data shows that, irrespective of PRR and NPR in most cases amylose contents are higher than amylopectin .By implication most landraces are non-glutinous while a few semi glutinous.*

**Key Words** – *Pigmented red rice (NPR), Non pigmented rice (NPR), Nutritional parameters, Carbohydrate fractions*

## I. INTRODUCTION

Among all crop species rice is known to have maximum agro biodiversity with over 40,000to 80,000 cultivars and vast majority of them are local landraces(Anon 2018) However in recent times, loss of agro biodiversity is assuming alarming proportion (Swaminanthan,2011), which have multiple implication. It appears that many valuable local landraces may be lost even before they are scientifically studied for their diverse qualities. It is known that many indigenous land races are very rich in nutritive values ( Baruah et al 2006, Loying et. al. 2010) and nutraceutical values (Loying et al, 2008, Moko et al 2014, Pengkumsri,et al ,2015). In the context of rice research the emerging concern is gene erosion. Assam and N.E India is considered as secondary centre of origin and diversity of paddy. The diversity is in terms of ecotypes, cultivation season, cultivation practice and more importantly unique taste, and aroma etc. The fact that international Rice research Institute, Manila has a separate rice collection as "Assam rice collection' is a testimony to the unique agro-biodiversity of the indigenous land races of Assam. As per record , before the large scale cultivation of high yielding varieties (HYV'S) there were over 7000 indigenous cultivars in Assam ( Borthakur,1992) . Although precise statistics is difficult to get there is apprehension that many local land- races are either lost or critically endangered. In Korapat district of the state Odisha during 1954 there were nearly 3000 local cultivars of paddy which is reduced to just in 300 by 2011(Swaminanthan 2011) .The implication is that many local landraces may be lost before they are scientifically evaluated for diverse traits. The commonly cited reason for not cultivating the local landraces is that they are low yielding while the positive aspects like valuable traits for nutritive, nutraceutical values, resistance to biotic and abiotic stress, wide adaptability etc, are overlooked. However with changing time and situation these traits are regaining their importance. Because HYV's are heavily dependent on chemical fertilizers, pesticides, irrigation etc and globally there is growing public opinion against use of these. In the backdrop of these the present study was undertaken to evaluate the nutritive values of some lesser known indigenous land races of paddy. Conservation must precede evaluation. Evaluation should be for diverse traits. In view of the growing awareness about food quality study of nutritional parameters deserve s priority.

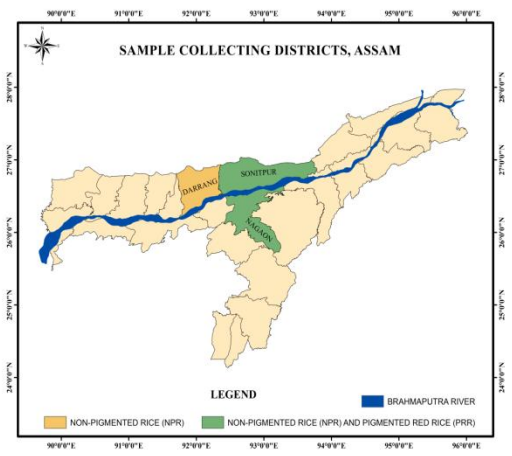


**Figure 1- Map location visualizing the three different districts of Assam, along with different sampling stations.**

Depending on cultivation practice, cultivation season and adaptation to ecological condition paddy of Assam are broadly classified into four groups (Borthakur 1992). Viz- Autumn rice (*Ahu*, February to May / Early june,) Kharif or winter rice (*Sali*- july to November / December). Spring rice (Boro – Nov / December – April / May); Deep water / Floating rice (Bao – March to November/ December). Among these kharif rice or sali is the dominant type with 66 % paddy area and 73% of Paddy production (Borthakur, 1992).

Attention of researchers is recently focused on red pigmented rice commonly referred to as "Red rice''. This red colouration (pigmented) is due to presence of anthocyanin pigment in varied amount in the pericarp of dehusked grain and its antioxidant property is well documented (Tiwary 2001, Loying et al 2008). The commonly consumed rice available in market is pigment less and called white rice to differentiate it from red rice. In Assam for all the four groups of rice both red rice and white rice cultivars are available .However not much is known whether both differ in terms of nutritive values or not.

## II. MATERIALS AND METHOD

### *A. Collection of paddy sample*

Altogether Twenty indigenous landraces of paddy were collected for evaluation. Among these ,eleven were pigmented red rice (PPR), and other nine landraces were non pigmented rice (NPR). All these landraces were collected from the different district of Assam, viz – Nagaon, Sonitpur, and Darrang. The PRR landraces used in this study were Amona (AM 1) Biroi ( BI2) , Kabra (KA3) Kabalam (KA4), Kabrabadam (KB 5), Bil Bao (BB 6) , Godasali (GS7) , Lalkartisali (LK8) , Ronga Kurmi(RK 9) , Kura Binni (KB 10) , Kokowa (KK11) , and the Non pigmented white landraces were Agnisali (AS 12) , Lotasali( LS 13) , Suhagmani (SM 14) , Kalizira ( KZ 15),Laki ( LK 16) , Tengeri ( TG 17) , Ranjit Amon (RA 18) , Boro ( BR 19) , Bismuthi ( BS 20) .

### *B. Preparation of rice samples and biochemical analysis*

Rice grain were manually dehusked and grounded into homogeneous fine powder. The samples were dried in oven at $55^0C \pm 1^0C$ till constant weight was recorded. For further analysis samples were kept in screw-capped plastic container at $4^0C$. Chemical analysis were carried out on dry weight basis.

**Table I –Different types of Indigenous pigmented (Red) and Non pigmented (white) rice varieties grown In Assam.**

| Rice growing season | Name of rice cultivar | Status |
|---|---|---|
| Ahu (Autumn paddy) (February – March ,May - June) | Amona<br>Laki | Pigmented (Red)<br>Non pigmented( White) |
| Sali (Coarse or bold, and fine grain) (winter paddy) (.June/July, Nov/ Dec). | Biroi, Kabra,Kabalam,Kabra badam, Godasali ,Lalkartisali,Rongakurmi , Kura binni .<br><br>Agnisali , Lotasali , Suhagmani Tengeri ,Kalizira , Bismuthi , Ranjit Amon | Pigmented (Red).<br><br>Non pigmented (White) |
| Bao(Coarse or bold grain)(.March / April Nov/ Dec) | KokowaBao, BilBao . | Pigmented (Red) |
| Boro( Tolerant to cold ) ( Dec ,Jan - May / June) | Boro | Non pigmented (White) |

Crude protein was estimated by working out the total nitrogen by microkjeldahl method (AOAC, 1970). Lipid content was estimated by extracting the sample with petroleum ether in soxhlet apparatus for eight hours and the amount of lipid was determined after removal of petroleum ether (AOAC, 1970). Crude fiber was estimated as per the method outlined by Sadasivam and Manickam (1996) .Ash content was determined by ashing the sample at $630^0c$ for 3 hours (AOAC, 1970). Total carbohydrate was estimated by anthrone method as outlined by Clegg (1956).Total soluble sugar was determined by the method of Yem

and Willis (1954).The method described by Chopra and Kanwar (1979) was used to estimate the starch content. Amylose content was determined as per the protocol of Thayumanavan and Sadasivam (1984). Amylopectin content was deduced by subtractions of the amylose content from starch content. Calorific value Calorific value was computed by the formula of Sherman (1952). Three replication were made for each sample and standard error of mean (SE±) was computed. The data were subjected to one way analysis of variance and the significance of variation was determined at 5% probability level and 1% probability level.

## III. RESULTS AND DISCUSSION

### *A. Carbohydrate and its fractions*

Among all nutritional components carbohydrate was the major fraction in terms of relative proportion. For red rice the range of variation was 64% to 80% signifying wide variability. Lowest value was observed in Rongakurmi with 64% while highest value was recorded in Kokowa with 80%. The corresponding range of variation for white rice was 62% to 69% in RanjitAmon and Tengeri respectively. Total soluble sugar for both red rice and white rice were nominal. For Red rice T.S.S varied from 0.44% in BilBao to 0.65% in Kabrabadam. For white rice also T.S.S content was comparable and the range of variation was from 0.46% in Agnisali to 0.89% in Boro. Starch content for both red rice and white rice exhibited identical trend. For red rice starch content varied from 44.06% in Amona to 65.31% in Rongakurmi. For white rice the corresponding range was 48.34% to 61.29% in suhagmani and Agnisali respectively. Like total carbohydrate starch content in both the group exhibited considerable variability and the intraspecific variation has been found to be statistically significant

Starch was further fractioned into amylose and amylopectin. For red rice amylose content varied from 24.03% in Amona to 34.45% in kokowa and the variation has been found to be significant. For white rice the range of variation was comparable with significant intraspecific variation. Compared to amylose, amylopectin content were little lower. For red rice amylopectin varied from16.36% in kokowa to 31.17% in BilBao. The corresponding range of variation for white rice was 16.58% in lotasali to 35.72% in laki. Estimation of amylose and amylopectin are of critical significance, because low amylose content in the range of 0.0 to 2.0% and a concomitant high level of amylopectin. is an indicator of glutinous rice (Houston 1972).In the present study the general trend is that amylose content is little higher than corresponding amylopectin content in all except few .Hence all the landraces in the present study can be considered as non glutinous . As per the classification of rice based on amylose content , rice with amylose content in the range of 20% -25% to is considered as intermediate value while those with amylose content above 25% is considered as high value and 10%- 20% range is considered as low amylose content . (IRRI 1985).

The present study shows that traditional landraces of rice exhibit significant variation and some of the landraces are found to have excellent nutritive values .Carbohydrate fractionation shows that all the red and white landraces in the present study belong to non glutinous rice category which is the staple food for all rice growing areas in Assam as well as India.

### *B. Protein content*

In the present study crude protein showed variation in the range of 8.20 % to 13.96 % among all the PRR and NPR varieties. Among red rice (PRR) crude protein varied from 8.20 % to 13 .96% which has been recorded for Kabrabadam (KB ) and Biroi (BI) respectively. For White rice (NPR) landraces the range of variation was 8.70% to 11.18% which has been recorded in the sample Bismuthi (BM) and Laki (LK) respectively. Protein content is considered as index for nutritional quality of rice and protein content of 10 % and above is considered as cultivar with high protein content (Ressurection et al 1979) .Rice contributes 24.1% of dietary protein out of 207.9 grams of rice consumed per day per person (FAOSTAT, 2001). The rice protein is superior to other cereal because of higher proportion of essential amino acids (Eggum, 1979). In the present study three red rice and two white rice landraces exhibited protein content of 10 % and above. Particularly the red rice Biroi with 13.96% protein is outstanding. Guha and Mitra (1963) working with 74 varieties of Brown paddy found protein in the range of 6.7% to 11%. Indigenous cultivars of the north eastern hill states of India posses high protein content with a range of 6.14 to 12.07% (Devi et al, 2008; Pramila Devi et al 2010) .Govindaswami et al (1996) reported 6% to 12.6% crude protein in three hundred improved rice varieties in India. Ahmed *et al.* (1998) working with nine aromatic rice of Assam reported that the crude protein content ranged from 9.17 to 11.77% .In the present study two aromatic landrace from NPR , kalizira and suhagmani recorded protein content 9.74% and 9.15% respectively , which is comparable to earlier reported values . Loying et al (2010) reported crude protein content in Baodhan ( deep water paddy) in the range of 9.63% to 13 .22%.Baruah et al (2006) working with ten indigenous land races of deep water paddy of Assam found crude protein in the range of 8 .03 to 13.20 %. With a mean value of 11.78% .The findings of the present study together with comparable earlier works strengthen the view that many indigenous landraces of paddy are nutritionally very rich and some are even superior to improved varieties.

### *C. Lipid content*

Among the red rice cultivars lipid content varied in the range of 1.72% in Biroi to 3.75% in BilBao implying wide variation among the cultivars. Among the white rice cultivars lowest lipid content were recorded in Bismuthi and Laki with 2.17 % and 2.31% respectively .On the other hand highest lipid was recorded in Suhagmani with 3.46% followed by Boro with 3.09%. For red rice cultivars the overall mean was 2.48%, while the overall mean for white rice cultivars was 2.31%, which shows that red rice cultivars have little higher lipid than white rice . Apart from nutritive value higher level of lipid contribute to taste and delicacy. Loying et al (2010) working with deep water paddy reported lipid in the range of 3.03% to 3.80% among red rice cultivars. Baruah et al (2006) working with similar indigenous deep water red rice cultivars observed lipid in the range of 2.42% to 4.64%. Another study involving 14 local landraces of Manipur and Nagaland, lipid content exhibited wide variation in the range of 1.2% to 4.2% with a mean of 2.49%.

### *D. Crude fiber and Total mineral as Ash content*

Compared to other major components the proportion of crude fiber and ash contents are relatively low and exhibit limited variation. In the present study for red rice landraces crude fiber content varied from 0.90% in lalkartisali to 1.67%. in Kura binni while the corresponding range of variation for white rice is 0.62% to 1.43% in Bismuthi and Agnisali respectively. By implication red rice have comparatively higher crude fibre. Crude fibre itself is not a food component since it is not digested but its positive role and importance in nutrition is well documented. In fact Indian council of Medical research has recommended a daily dietary intake of 25 – 40 gram fibre (Gopalan et al 1989).Adequate intake of crude fibre help to prevent various gastro intentional problems like constipation (Gopalan et .al 1989) .Recent studies have shown that food with high dietary fibre like fenugreek seed are effective in reducing blood glucose and cholesterol and useful in reducing obesity (Gopalan et al 1989) .

**Table -II .Carbohydrate, Total Soluble Sugar, Starch , Amylose and Amylopectin, total crude Protein content, lipid, crude fiber, total mineral content, and calorific values Content of Eleven PPR landraces.**

| Pigmented red rice (PRR) cultivars | Moisture content (%) ±SEm | Carbohydrate (%)±SEm | T.S.S (%)±SEm | Starch (%) ±SEm | Amylose (%)±SEm | Amylopectin (%)±SEm | Protien (%)±SEm | Lipid(%) ±SEm | Crude fibre(%)±SEm | Total mineral (%) ±SEm | Total calorific value Kcal /100 gm ±SEm |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Amona | 11.07±0.38 | 73.56±0.29 | 0.45±0.03 | 44.06±0.33 | 24.03±0.33 | 20.03±0.90 | 10.05±0.03 | 2.63±0.17 | 1.31±0.02 | 1.38±0.04 | 358.11 |
| Biroi | 13.36±0.40 | 68.65±0.33 | 0.51±0.01 | 56.87±0.63 | 31.72±0.66 | 25.15±0.50 | 13.96±0.07 | 1.72±0.10 | 1.36±0.02 | 0.95±0.03 | 345.92 |
| Kabra | 12.18±0.49 | 69.40±0.57 | 0.47±0.02 | 56.35±0.57 | 34.04±0.39 | 22.31±0.60 | 9.57±0.23 | 1.95±0.08 | 1.12±0.03 | 0.84±0.04 | 333.43 |
| Kabalam | 12.86±0.61 | 64.10±0.52 | 0.48±0.02 | 55.02±0.27 | 32.32±0.50 | 22.70±0.46 | 8.50±0.23 | 2.18±0.10 | 0.93±0.02 | 1.15±0.04 | 314.79 |
| Kabrabadam | 10.25±0.49 | 68.80±0.42 | 0.65±0.02 | 59.14±0.34 | 30.30±0.46 | 28.84±0.43 | 8.20±0.09 | 2.76±0.13 | 1.20±0.02 | 1.18±0.03 | 327.62 |
| BilBao | 13.96±0.52 | 75.30±0.31 | 0.44±0.02 | 58.73±0.43 | 27.56±0.40 | 31.17±0.67 | 8.53±0.06 | 3.75±0.10 | 1.10±0.02 | 1.07±0.04 | 366.46 |
| GodaSali | 12.17±0.42 | 74.30±0.40 | 0.46±0.02 | 59.18±0.21 | 31.60±0.36 | 27.58±0.37 | 8.50±0.05 | 2.71±0.12 | 0.92±0.02 | 1.40±0.04 | 356.04 |
| Lalkartisali | 12.80±0.83 | 68.00±0.61 | 0.59±0.03 | 58.10±0.25 | 31.55±0.32 | 26.55±0.45 | 10.56±0.12 | 2.63±0.07 | 0.90±0.02 | 0.99±0.01 | 337.95 |
| Rongakurmi | 13.45±0.53 | 64.00±0.61 | 0.51±0.01 | 65.31±0.28 | 31.16±0.31 | 34.15±0.53 | 9.23±0.06 | 2.33±0.13 | 1.41±0.03 | 1.23±0.02 | 313.89 |
| Kura Binni | 9.52 ±0.30 | 70.00±0.14 | 0.50±0.02 | 54.36±0.53 | 24.89±0.46 | 29.47±0.38 | 9.87±0.05 | 2.18±0.15 | 1.67±0.03 | 0.83±0.01 | 339.10 |
| Kokowa | 13.14±0.38 | 80.00±0.61 | 0.45±0.02 | 50.81±0.61 | 34.45±0.39 | 16.36±0.53 | 9.33±0.06 | 2.43±0.14 | 1.50±0.04 | 1.22±0.04 | 379.19 |
| Mean (X) | 12.25 | 70.55 | 0.50 | 56.17 | 30.32 | 25.84 | 9.663 | 2.47 | 1.22 | 1.11 | 342.95 |
| CD at 5% | 1.85 | 1.012 | 0.021 | 1.106 | 1.14 | 1.12 | 0.79 | 1.12 | 0.34 | 0.41 | 3.040 |
| CD at 1% | 2.63 | 1.434 | 0.048 | 1.570 | 1.57 | 1.50 | 1.13 | 0.75 | 0.49 | 0.59 | 4.311 |

**Table -III. Carbohydrate, Total Soluble Sugar, Starch , Amylose and Amylopectin, Total crude Protein content, lipid, crude fibre, total mineral content, and calorific values Content of Nine NPR landraces.**

| Non pigmented rice (NPR) cultivars | Moisture (%)±SEm | Carbohydrate (%)±SEm | T.S.S (%)±SEm | Starch(%) ±SEm | Amylose (%)±SEm | Amylopectin (%) ±SEm | Protien (%)±SEm | Lipid (%)±SEm | Crude fibre(%)±SEm | Total mineral (%)±SEm | Total calorific value(kcal/gm) (%)±SEm |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Agnisali | 12.83±0.42 | 64.00±0.63 | 0.46±0.01 | 61.29±0.77 | 29.33±0.44 | 31.96±0.70 | 8.89±0.05 | 2.50±0.11 | 1.43±0.02 | 0.35±0.03 | 314.06 |
| Lotasali | 10.90±0.56 | 64.80±0.34 | 0.63±0.02 | 51.22±0.58 | 34.64±0.29 | 16.58±0.42 | 9.89±0.04 | 2.36±0.08 | 1.25±0.03 | 0.80±0.03 | 320.00 |
| Suhagmani | 12.53±0.66 | 68.10±0.47 | 0.47±0.02 | 48.34±0.57 | 30.39±0.50 | 17.95±0.53 | 9.15±0.06 | 3.46±0.05 | 0.83±0.02 | 0.93±0.02 | 324.00 |
| Kalizira | 13.25±0.32 | 66.00±0.61 | 0.59±0.04 | 52.63±0.51 | 33.38±0.28 | 19.25±0.71 | 9.74±0.07 | 2.79±0.11 | 1.25±0.03 | 1.12±0.01 | 322.58 |
| Laki | 13.45±0.34 | 65.00±0.61 | 0.82±0.02 | 62.74±0.97 | 27.02±0.51 | 35.72±0.49 | 11.1±0.05 | 2.31±0.23 | 1.12±0.03 | 1.14±0.03 | 349.51 |
| Tengeri | 12.92±0.74 | 69.00±0.54 | 0.70±0.01 | 51.93±0.61 | 34.06±0.38 | 17.87±0.60 | 9.97±0.02 | 2.76±0.06 | 1.03±0.02 | 0.32±0.02 | 347.55 |
| RanjitAmon | 12.27±0.47 | 62.00±0.67 | 0.57±0.02 | 51.28±0.46 | 33.67±0.54 | 17.61±0.55 | 11.0±0.03 | 2.88±0.08 | 0.70±0.02 | 1.09±0.01 | 318.16 |
| Boro | 13.46±0.45 | 68.40±0.36 | 0.89±0.04 | 59.62±0.51 | 30.39±0.35 | 29.29±0.46 | 9.85±0.10 | 3.09±0.10 | 0.86±0.02 | 1.34±0.02 | 340.81 |
| Bismuthi | 12.18±0.79 | 67.50±0.35 | 0.60±0.02 | 51.06±0.38 | 24.50±0.37 | 26.56±0.47 | 8.70±0.09 | 2.17±0.10 | 0.42±0.01 | 1.43±0.02 | 324.33 |
| Mean (X) | 12.64 | 66.08 | 0.636 | 54.45 | 30.82 | 23.64 | 9.82 | 2.70 | 0.98 | 0.94 | 329.00 |
| CD at 5% | 1.01 | 1.555 | 0.071 | 1.120 | 1.417 | 1.722 | 1.397 | 0.564 | 0.320 | 0.204 | 2.82 |
| CD at 1% | 1.38 | 1.138 | 0.054 | 0.894 | 1.037 | 1.262 | 1.900 | 0.610 | 0.440 | 0.278 | 3.08 |

There are diverse reports of crude fibre content in different indigenous paddy cultivar. Loying et al (2010) working with indigenous deepwater rice reported crude fibre in the range of 0.45% to 0.90%, while Baruah et al (2006) working with similar rice, reported in the range of 0.36% to 0.53 %. It appear that most of the landraces in the present study have comparatively higher and impressive amount of crude fibre .In case of total mineral in the form of ash content the range of variation was 0.83% to 1.40% .while the corresponding range for white rice was 0.64% to 1.43% . This implies that there is not much appreciable difference between red rice and white rice so far ash content is concerned. The findings of the present study are comparable to reports of earlier workers like Sotelo et al(1990) , Edeogu et al (2007), Awan (1996) ,Tufatil ( 1997) et al .

### *E. Calorific value*

The variation in nutritive values is reflected in the calorific values. For red rice calorific values varied from313.89 kcal in Rongakurmi to 379.19 kcal in kokowa with a mean of 342.95. For white rice the range of variation was 314.06 kcal in Agnisali to 349.51 kcal in Laki with a mean of 329.00 kcal.

## IV. CONCLUSION

On comparative basis red rice are superior in nutritive values than white rice. Earlier studies also reported that red rice are very rich in nutritive values ( Baruah et al 2006 , Loying et al 2010 ) as well as nutraceutical value due to presence of significant amount of anthocyanin and phenolics ( Loying et al 2008 , Moko et al 2014 ; Pengkumsri et al 2015) . In view of alarming loss of agro- biodiversity there is a growing concern for conservation of traditional landraces of paddy .However conservation must precede evaluation. This and similar study can help in short listing the superior landraces for further works and utility.

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