Nutritional Analysis And Cooking Quality Parameter Of White, Red And Black Rice Cultivar Of Manipur By Using Scanning Electron Microscope And EDAX

Koijam Samson Singh, G.A. Shantibala Devi

Abstract: The analysis of the three rice varieties was carried out in the Department of Life sciences and Department of physics, Manipur University. The laboratory analysis was carried out to assess the cooking quality and elemental composition of three local aromatic rice cultivars of Manipur. The aromatic rice cultivars of white (chakhao abngouba), red (chakhao angangbi) and black (chakhao amubi) grain samples were collected from the local farmer and analysed for its cooking quality and elemental composition. All the three aromatic rice varieties are medium slender in L/B ratio. All the three varieties had recorded the maximum hulling and milling percentage than the other land races which are cultivated in the valley of Manipur. Among these varieties, the white get cooked rapidly. Higher grain elongation and volume expansion ratio was observed in all the three varieties along with higher concentration of anthocyanin, carbohydrates, protein, phenol, fibre and fat. All the three varieties were with elements of C, N, O, Fe, Al, S, and K

Index Terms: White (chakhao abngouba), Red (chakhao angangbi) and Black (chakhao amubi), nutritional analysis, cooking quality, Scanning electron Microscope and EDAX.

1 INTRODUCTION

Rice has been one of the most important staple food for more than half of the Indian population, more than half of the world populations depend on this cereal as their staple food, mainly in developing nations. In Asian countries like China, India, Bangladesh, Bhutan etc., rice is the major dietary source for energy, protein, vitamins and minerals. Rice is one of the world's leading sources of nutrition for mankind since time immemorial, comes in hundreds of varieties and in many other colours. Several indigenous rice varieties of this state are mainly of white, red and black colour. The aroma bearing rice grains of this state has a more complex taste and contains more nutritious, fibre-filled bran than any other lighter-coloured rice. The difference in the colour of these rice varieties is mainly due to the difference in the quantity of anthocyanin present in their bran layer. Black rice grain has a more complex taste and contains more nutritious, fibre-filled bran than many lighter coloured rice. The colour is confined to the bran layer, a tinge of red and black remains even after a high degree of milling. The red and black bran layer contains polyphenols and anthocyanin, and possesses antioxidant properties. The inner portion of these three rice is alike and white [9]. The anthocyanin, protein and phenol content of red and black rice is higher than that of white rice [8].The change in food habits in the people of the state from traditional foods to junk foods has increased the risk of lifestyle-related health issues and diseases such as hypertension, diabetes, cancer, heart problems etc.

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Red and black rice meets most of the requirements of a healthy good food. The red and black rice are considered to be highly nutritive and medicinal without knowing the elemental composition of these rice. To find out the elemental composition of this three rice the present study was carried out.

2 MATERIALS AND METHODS

The three aromatic rice races of traditional cultivars were collected from field of the farmer during the crop season and samples were analysed for its surface features and elemental composition using SEM and SEM with EDAX. Here, a wide range of magnifications is possible, from smallest as 10 times (equivalent to magnification of a simple microscope) to more than 10, 00,000 times. For taking images of sample, about 0.5 to 1.0 mg of sample was placed on the carbon conducting tape. Energy Dispersive X-Ray Spectroscopy (EDAX) is a chemical micro analysis technique used in conjunction with scanning electron microscopy (SEM). The EDAX technique, which detects the X-Rays emitted from the sample during bombardment by an electron beam to characterize the elemental composition of the analysed sample. The elemental characteristic is emitted in the form of X-ray energy. For recording the chemical composition of sample, about 0.5 to 1.0 mg of sample was place on the carbon conducting tape. Then the tape was mounted on the sample stage and the elemental composition of the samples was recorded using EDAX attached in the FEI ESEM model “QUANTA 250” available in the Department of physics, Manipur University, Canchipur. The physio-chemical, milling characteristics of grains and cooking quality parameters were analysed from five hundred gram of dried paddy grain samples which were dehulled in Satake dehusker as characterized by the methods described by [1]. Determination of Aroma was done by following the method of [6]. Cooking quality parameters was estimated by the method outlined by [3]. After dehulled, the rice grains were powdered by using pestle and mortar and made into a fine powder or rice flour. From the flour, Carbohydrate (Anthrone method), Gel consistency [14] Protein (Micro kjeldahl), Phenol [13] Fibre (Acid and alkali titration),

Fat (Soxhlet apparatus method) were analyzed.

Figure-1: (*A) & (a) are the paddy and rice grain of chakhao angouba, (B) & (b) are the paddy and the rice grain of chakhao angangbi and (C) & (c) are the paddy and rice grain of chakhao amubi.*

3 RESULT AND DISCUSSION

3.1 Morphology

The surface morphology of all three rice varieties was examined, The grain shape was determined on the basis of the length and breadth ratio of the milled rice samples measure by using digital slide calliper, while the grain appearance was ascertained on the basis of the kernel size, translucency and chalkiness of the rice kernels. The L/B ratio of 3 is generally considered as slender. All the three aromatic rice varieties had L/B ratio of less than 3 (Chakhao angouba - 2.45±0.032, chakhao angangbi - 2.23±0.018, chakhao amubi - 2.57±0.044). Based on the finding of the observations of these selected aromatic rice varieties it reveals that all the three varieties are medium slender. Similar observation had also been reported by [10] in red rice TPS 1 and TKM 9 and [12] in brown rice land races. According to the observation of measurement on length, the grains of all the three aromatic rice varieties are classified as long grains. As per the kernels width all these rice varieties are classified as short grains. This result was in conformity with [11] and [10].

Table-1 *Hulling and grain characteristics of the three rice varieties.*

Name of the varieties	*100 grain weight in gram*	*Grain length (mm)*	*Grain breadth (mm)*	*L/B ratio*
Chakhao angouba	*2.40±0.040*	*6.51±0.044*	*2.65±0,020*	*2.45±0.032*
Chakhao angangbi	*2.01±0.076*	*6.14±.0.025*	*2.74±0.023*	*2.23±0.018*
Chakhao amubi	*2.55±0.049*	*6.14±.0.025*	*2.64±0.029*	*2.57±0.044*

3.2 MILLING CHARACTERISTICS (PERCENT) OF THREE AROMATIC RICE VARIETIES

Among these three traditional aromatic varieties, the highest hulling per cent of 79.89±0.758 and milling per cent of 65.08±0.883 was noted in variety Chakhao angouba, Followed by Chakhao angangbi with hulling percent of 78.63±0.343 and milling percent of 61.02±1.666. The least hulling and milling per cent of 76.65±0.590 and 60.46±1.032 respectively, was recorded with Chakhao amubi. Higher whole grain recovery percent of 45.89±1.451 was recorded with Chakhao angouba followed by Chakhao angangbi with 44.83±1.264 and chakhao amubi with 44.12±1.345 percent respectively. Among these traditional aromatic rice variety the lowest milling loss of 8.94 and 9.32 per cent was recorded in variety Chakhao angouba and Chakhao angangbi, respectively while chakhao amubi is recoded with highest milling loss of 10.26 percent. This resulted that there is reduction of milling loss and higher whole grain recovery. This influenced on whole kernel recovery and reduction in milling loss of Chakhao angouba. [5] while observing the milling characteristics of eighteen paddy varieties grown in India. Similar results were also reported by [10] in red rice and [2] in medicinal red rice variety Njavara.

Table-2 *Milling characteristics (per cent) of the three rice varieties.*

Name of the varieties	*Hulling %*	*Milling %*	*Whole grain recovery %*	*Milling loss %*
Chakhao angouba	*79.89±0.758*	*65.08±0.883*	*45.89±1.451*	*8.94*
Chakhao angangbi	*78.63±0.343*	*61.02±1.666*	*44.83±1.264*	*9.32*
Chakhao amubi	*76.65±0.590*	*60.46±1.032*	*44.12±1.345*	*10.26*

3.3 COOKING QUALITY PARAMETERS OF SELECTED RED RICE VARIETIES

The variation in cooking quality parameters like, cooking time (minutes), water uptake (ml/g), gel consistency (mm) volume expansion ratio and grain elongation ratio were also studied in all the three aromatic rice. The results revealed that higher cooking time of 50 minutes were taken by variety chakhao angangbi and chakhao amubi while the cooking time of 40 minute was taken by the chakhao angouba respectively. The cultivar chakhao amubi found to uptake more quantity of water during cooking with 297.97±0.718 ml/100g followed by chakhao angangbi with 293.09±1.324 ml/100g. The lowest water uptake of 280.65±1.680 ml/100g was recorded in cultivar chakhao angouba. The maximum grain volume expansion ratio was recorded in the cultivar chakhao amubi with 4.15±0.024 followed by the cultivars chakhao anhouba and chakhao angangbi with 4.14±0.012 and 4.07±0.051 respectively. The highest kernel elongation ratio was observed in the case of chakhao angouba with 1.48±0.065 followed by chakhao amubi and chakhao angangbi with 1.35±0.032 and 1.23±0.014 respectively. The highest gel consistency was recorded in the cultivars Chakhao angangbi with 98.36±0.54 mm while the lowest value of gel consistency was recorded in the case of the cultivar chakhao amubi with 73.20±0.35 and that of the chakhao angouba was found to be 98.12±0.54 mm. The higher volume and grain expansion ratio of all the three aromatic rice cultivars might be due to longer cooking time as compare to other improved varieties which resulted in higher water uptake for cooking. During cooking kernels of all the three aromatic rice were split because of longer cooking time and higher fibre content. This splitting nature and longer cooking time of all these aromatic rice led to the less recovery

of solids after cooking. The higher grain elongation ratio of all these aromatic rice after cooking might be due to higher uncooked grain length, width and L/B ratio. Similar finding were also reported by [12].

Table-3A *Cooking quality parameters of the three aromatic rice varieties.*

Name of the varieties	*Aroma*	*Cooking time (min)*	*Water uptake (ml/100g)*
chakhao angouba	*Medium*	*40*	*280.65±1.680*
Chakhao angangbi	*Medium*	*50*	*293.09±1.324*
chakhao amubi	*strong*	*50*	*297.97±0.718*

Table-3B *Cooking quality parameters of the three aromatic rice varieties*

Name of the varieties	*Volume expansion ratio*	*Kernel elongation ratio*	*Gel consistency (mm)*
chakhao angouba	*4.14±0.012*	*1.48±0.065*	*98.12±0.54*
Chakhao angangbi	*4.07±0.051*	*1.23±0.014*	*98.36±0.54*
chakhao amubi	*4.15±0.024*	*1.35±0.032*	*73.20±0.35*

3.4 Biochemical Properties

In table-4, the data relating the content of anthocyanin, carbohydrates, protein, phenol, fibre and fat of these three aromatic rice varieties were studied. Among these aromatic rice varieties higher anthocyanin and fibre content was observed in the rice cultivar chakhao amubi with 428.33±12.59 and 2.12 percent respectively followed by chakhao angangbi with anthocyanin content of 163.78±8.756 and fibre content of 2.05 percent. The lowest anthocyanin and fibre content was recorded in the cultivar chakhao angouba with 016.82±3.176 and 0.89 percent. The lowest concentration of carbohydrates content was observed in case of the cultivar chakhao angangbi with 70.32 per cent while the highest concentration was observed in the case of the chakhao angouba followed by chakhao amubi with 71.06 and 70.45 percent respectively. From this table it is also observed that the highest phenol content was observed in case of the cultivar chakhao angangbi with 2.460±0.120 mg/g and in case of the chakhao amubi and chakhao angouba it was found to be 1.698±0.083 mg/g and 0.222±0.034 mg/g respectively. Among these three aromatic rice cultivars the highest protein content was found in the cultivar chakhao amubi with 3.139±0.112 mg which was followed by chakhao angouba and chakhao angangbi with 2.541±0.162 mg/g and 1.083±0.037 mg/g respectively. The lowest fat content of 3.41 percent dry weight was recorded in the rice cultivar chakhao amubi while in case of chakhao angouba and chakhao angangbi it was found to be 3.84 percen and 3.71percen of dry weight. Similarly finding was also reported by [4] and [7] in eleven and five traditional red rice varieties, respectively.

Table-4A *Biochemical Properties of the three aromatic rice varieties.*

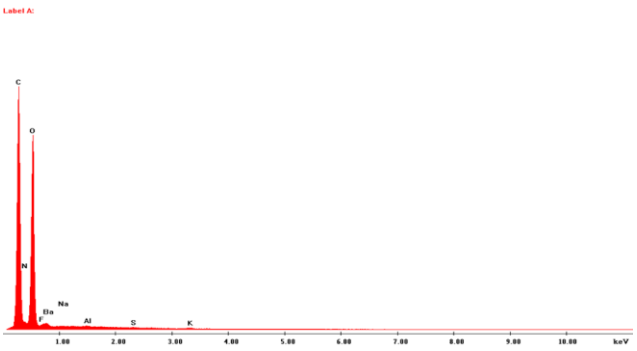
Name of the varieties	*Anthocyanin content (mg/100g)*	*Fiber (%)*	*Carbohydrate (%)*
chakhao angouba	*016.82±3.176*	*0.89*	*71.06*
Chakhao angangbi	*163.78±8.756*	*2.05*	*70.32*
chakhao amubi	*428.33±12.59*	*2.12*	*70.45*

Table-4B *Biochemical Properties of the three aromatic rice varieties.*

Name of the varieties	*Phenol (mg/g)*	*Protein (mg/g)*	*Fat (% in dry weight)*
chakhao angouba	*2.541±0.16*	*2.541±0.162*	*3.84*
Chakhao angangbi	*2.460±0.120*	*1.083±0.037*	*3.71*
chakhao amubi	*1.698±0.083*	*3.139±0.112*	*3.41*

3.5 Energy dispersive X-ray spectroscopy (EDAX)

The EDAX analysis data of these three aromatic rice confirmed the elemental composition of these rice varieties [Fig-1, 2, and 3]. The major elements detected in the cultivar Chakhao angouba were carbon with 47.10 per cent, oxygen with 46.52 percent and nitrogen with 4.90 percent and other elements like F, Na, Al and S are also detected with low percentage. In the case of chakhao angangbi the major elements detected were carbon with 49.50 percent, oxygen with 42.28 percent, nitrogen with 5.45 percent while the elements like Fe, Al and S are also detected in very low percent as in the case of the chakhao amubi the major elements detected were carbon with 51.00 percent, oxygen with 41.85 percent and iron with 7.01 percent, the elements like Al and Ca are also detected in very low concentration. The EDAX data of these three aromatic rice cultivars indicates the nutrient richness of all the three rice varieties. However, the presence of zinc and some other elements in trace quantity were also reported by several scientist, however in our present study of SEM with EDAX does not observed zinc and any other trace elements peaks irrespective of all the aromatic rice cultivars.

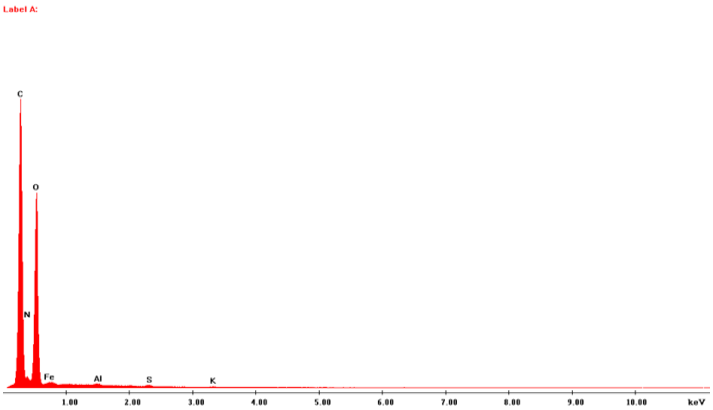


kV: 20.00 Tilt: 0.00 Take-off: 25.00 AmpT: 6.40
Det Type:SDD Apollo X Res: 131.20 Lsec: 33

Element	*Wt %*	*At %*	*K-Ratio*	*Z*	*A*	*F*
C K	*47.10*	*54.07*	*0.2535*	*1.0093*	*0.5329*	*1.0005*
N K	*4.90*	*4.83*	*0.0066*	*1.0005*	*0.1351*	*1.0010*
O K	*46.52*	*40.09*	*0.0928*	*0.9925*	*0.2010*	*1.0000*
F K	*1.24*	*0.90*	*0.0015*	*0.9329*	*0.1338*	*1.0000*
NaK	*0.07*	*0.04*	*0.0002*	*0.9293*	*0.3195*	*1.0000*
AlK	*0.08*	*0.04*	*0.0005*	*0.9249*	*0.6269*	*1.0000*

S K	*0.02*	*0.01*	*0.0002*	*0.9307*	*0.9438*	*1.0001*
K K	*0.07*	*0.02*	*0.0006*	*0.8995*	*1.0330*	*1.0000*

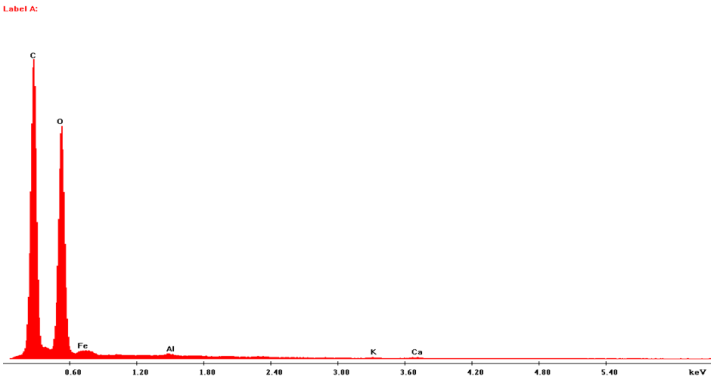
EDAX ZAF quantification standard less sec table: default
Figure 2A. SEM-EDAX analysis report of white aromatic rice chakhao angouba grain.



kV: 20.00 Tilt: 0.00 Take-off: 25.00 AmpT: 6.40
Det Type:SDD Apollo X Res: 131.20 Lsec: 28

Element	*Wt %*	*At %*	*K-Ratio*	*Z*	*A*	*F*
C K	*49.50*	*57.20*	*0.2625*	*1.0113*	*0.5242*	*1.0004*
N K	*5.45*	*5.40*	*0.0071*	*1.0025*	*0.1292*	*1.0009*
O K	*42.28*	*36.68*	*0.0802*	*0.9945*	*0.1906*	*1.0001*
Fe L	*2.59*	*0.64*	*0.0060*	*0.8526*	*0.2733*	*1.0000*
Al K	*0.07*	*0.04*	*0.0004*	*0.9267*	*0.6205*	*1.0001*
S K	*0.06*	*0.02*	*0.0005*	*0.9330*	*0.9390*	*1.0003*
K K	*0.05*	*0.02*	*0.0005*	*0.9014*	*1.0303*	*1.0020*

EDAX ZAF quantification standard less sec table: default
Figure 2B. SEM-EDAX analysis report of red aromatic rice Chakhao angangbi grain.



kV: 20.00 Tilt: 0.00 Take-off: 25.00 AmpT: 6.40
Det Type:SDD Apollo X Res: 131.20 Lsec: 26

Element	*Wt %*	*At %*	*K-Ratio*	*Z*	*A*	*F*
C K	*51.00*	*60.72*	*0.2489*	*1.0171*	*0.4796*	*1.0004*
O K	*41.85*	*37.41*	*0.0868*	*1.0002*	*0.2074*	*1.0002*
FeL	*7.01*	*1.79*	*0.0172*	*0.8575*	*0.2857*	*1.0000*
AlK	*0.13*	*0.07*	*0.0007*	*0.9319*	*0.5881*	*1.0001*
CaK	*0.02*	*0.01*	*0.0002*	*0.9288*	*1.0317*	*1.0087*
K K	*0.00*	*0.00*	*0.0000*	*0.9070*	*1.0210*	*1.0050*

EDAX ZAF quantification standard less sec table: default
Figure 2C. SEM-EDAX analysis report of black aromatic rice Chakhao amubi grain.

4 CONCLUSION

The analysis of three traditional aromatic rice cultivar which was observed to be higher nutritional content than the normal non aromatic rice, thus these traditional aromatic rice variety process higher nutritional values than other white rice varieties and can play an important role in our food diet and other applications may be studied in future for better utilization of these aromatic rice cultivars.

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