Nutritional and functional properties of eleven hybrid and land-race rice varieties from Assam, India

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KEYWORDS
Rice, Landrace, Proximate composition, DPPH

ABSTRACT:
Rice is one of the most important food crop in the world which provides a primary source of dietary energy, particularly in Asia. It is a flexible and health-promoting staple due to its nutritional richness in carbohydrates, protein, and other essential phytochemicals. This study investigates the proximate composition, functional properties, and biochemical characteristics of eleven rice cultivars from Dhubri district, Assam. Key findings indicate that varieties such as Rupahi, Bahadur Sub-1, Lalpeda, Geda Gedi, Ranjit Sub-1, and Natun Aijong exhibit superior qualities in various parameters. Proximate analysis reveals that the Lalpan variety exhibits the highest fat content (4%), Kola Mota has the highest crude fiber content (2.80%), Bahadur Sub-1 contains the highest protein content (13.77%), Natun Aijong has the highest carbohydrate content (86.54%), and Chapar Aijong shows the highest food energy value (412.1 kcal). In functional properties, Lalpeda demonstrates the highest water absorption capacity (1.2506 g/L) and water solubility index (0.0933 g/L), while Geda Gedi has the greatest swelling power (0.0114). The highest oil absorption index is found in Bahadur Sub-1 (0.348). Additionally, Lalpeda shows the highest total phenolic content (0.0024 µg/mg), Rupahi has the highest total flavonoid content (13.59 mg/g) and amylase content (18.76%), while Natun Aijong has the highest starch content (77.88%). Among all varieties, Rupahi and Bahadur Sub-1 consistently demonstrate enhanced nutritional and functional attributes, identifying them as promising candidates for both cultivation and commercial applications. This research contributes valuable insights into the nutritional diversity of Assamese rice landraces.

1. Introduction

An important cereal food crop of worldwide importance is rice (*Oryza sativa* L.). It is the second most produced food in the world after wheat, with around 680 million tons grown year [1]. It is a major food crop that is consumed by a significant proportion of the world's population, primarily in Asia. The principal producers of rice are Brazil, Japan, India, China, and Pakistan [2]. It is an autogamous crop with fewer than 5% cross-pollination [3].

In Indian culture, rice holds a unique role from ancient times. It is associated with a number of harvest celebrations, such as Kerala's Onam, Tamil Nadu's Pongal, Punjab's Lohri, and Assam's Bhogali Bihu [4]. According to Food and Agriculture Organization (FAO), 500.5 million metric tons of rice were produced worldwide between April and June,2015. India produces a large amount of rice and is a major exporter of the commodity worldwide. India was one of the biggest exporters of rice in 2014, accounting for 32% of global exports [5]. India's rice-growing regions can be roughly divided into five categories: Eastern, North-Eastern, Northern, Southern, and Western. Assam is one of the principal rice-producing states in Northeastern India, contributing significantly to the country's GDP. Around 70 percent of Assamese arable land is used for rice cultivation [6]. Although rice is mostly used as a source of carbohydrates, it also contains significant amounts of fat, protein, and many minerals, including vitamin B complex. According to Verma *et al.,* (2017), rice grains typically include 12% moisture content, 7% highly digestible protein content, and 70–80% carbohydrates. Although rice protein content is about 7%, it is highly digestible and has a higher biological value compared to other plant protein sources. The proximate properties i.e. crude protein, moisture content, crude fat, crude fibre, crude carbs, and crude ash, along with biochemical traits like starch and amylose content, are essential for identifying rice varieties that may support improved nutritional benefits [7].

The primary type of rice carbohydrate is starch that is unique due to its small particle size and hypoallergenic properties [8]. Rice grains with a high amylose content are generally less sticky, while those with a low amylose concentration which tends to be stickier [9]. The nutritional value of rice is further increased by phytochemicals such as flavonoids, anthocyanins, and phenolic compounds, which have antioxidant qualities that help scavenge reactive oxygen species (ROS) and stop cellular damage [10]. Furthermore, phytochemicals in rice prevents peroxidation of lipids by lipoxygenase (LOX), which results in toxic aldehyde compounds [11].

Although rice is usually consumed cooked, its flour is also used to make bread, snacks, and other goods. Because of their distinct nutrient profiles, traditional Assamese rice cultivars especially landraces have been linked to positive health outcomes. Understanding the functional and nutritional qualities as well as the behavior of rice flours in food formulations is essential for optimizing their dietary benefits. Furthermore, research on rice cultivars with low glycemic index (GI) and high resistant starch content may help validate dietary guidelines for people with diabetes and other metabolic disorders. This study aims to identify rice varieties with improved nutritional value and functional properties by examining the proximate composition, biochemical properties, and phytochemical contents.

2. Materials & Methods

2.1 Collection of Plant material: Eleven varieties of rice cultivars have been collected from Dhubri district of Assam, India, in the month of November. **Table 1** demonstrate the different landraces used in the experiment.

Sl No.	Name	Collection Area	Type of variety (Landrace /Hybrid)	GPS Location
1.	Ranjit	South salmara	Hybrid	25.8048, 89.8879
2.	Bahadur sub-1	Dharmasala	Hybrid	26.0250, 89.8877
3.	Natun aijong	Hatidhura	Landrace	26.3227, 89.8546
4.	Phul pakhri	Rupshi	Landrace	26.1379, 89.9083
5.	Chapar aijong	Hatidhura	Landrace	26.3227, 89.8546
6.	Ranjit sub1	Gauripur	Hybrid	26.0916, 89.9655
7.	Geda Gedi	Rupshi	Landrace	26.1379, 89.9083
8.	Lalpeda	Bilasipara	Landrace	26.2298, 90.2304
9.	Kola mota	Mahamaya	Landrace	26.0185, 89.9889
10.	Lalpan	Mahamaya	Landrace	26.0185, 89.9889
11.	Rupahi	Hatidhura	Landrace	26.3227, 89.8546

Table I: Collected rice samples and collection area.

2.2. Proximate Properties of rice

The crude fiber content was measured using AOAC 978.10 method. The crude fat content was measured by AACC (2000) method. The protein content was measured using the Lowry (1951) method. The crude carbohydrate content was determined using anthrone method. The rice sample's total food energy was measured by difference method [12-14].

2.3. Functional Properties of rice

2.3.1. Hydration properties

The hydration properties including Water Solubility Index (WSI), Water Absorption Index (WAI), and Swelling Power (SP) was evaluated using the method described by Bryant *et al.*, (2001) [15]. For the determination of WAI and WSI, 500 mg of the rice sample was put into a centrifuge tube. For suspension, roughly 10 ml of pure water were added. After 30 minutes of shaking, the mixture was centrifuged for an additional 30 minutes at 2000 rpm. The resultant supernatants were transferred to an evaporating plate and dried in an oven set at 100°C for 12 hours. The values of WAI, WSI and SP were measured using the given formula.

$$WAI = \frac{\text{Weight of the wet supernatant (g)}}{\text{Weight of the rice samples (g)}} \tag{1}$$

$$WSI = \frac{\text{Weight of the dried supernatant (g)}}{\text{Weight of the rice samples (g)}} \tag{2}$$

$$\text{SP} = \text{WAI} \times \frac{1-\text{WSI}}{100} \tag{3}$$

2.3.2. Oil Absorption Index (OAI)

OAI was evaluated using the method outlined by Bryant *et al.*, (2001), with a few minor modifications [15]. In this method, 500 mg of rice flour samples was taken in a pre-weighed centrifuge tube along with 0.5 ml of vegetable oil and sealed tightly. The mixture was centrifuged at 2000 rpm for 30 minutes. Following centrifugation, the supernatant was carefully drained off, and the residual materials were weighed. The given formula was used to calculate OAI:

$$\text{OAI} = \frac{\text{Weight of the oil absorbed (g)}}{\text{Weight of the flour sample (g)}} \tag{4}$$

2.4. Biochemical analysis

2.4.1. Determination of Total Phenol Content (TPC)

The total phenol content of rice samples was measured using Folin–Ciocalteau phenol reagent utilizing the method of Mc Donald *et al.*, (2001) [16]. For standard, 1mg standard gallic acid was dissolved in 1ml of distilled water and serially diluted at 20,40,60,80 and 100 µg/ml concentrations. Calibration curve was prepared by adding 1ml of different gallic acid concentration,5ml of 0.2 N Folin-Ciocalteu reagent and 4ml of 75g/l Na_2CO_3. Blank was prepared by using 1ml of distilled water except gallic acid. Accordingly, long with the reagent mentioned above, 1 milliliter of sample solution (1000 µg/ml) was added, and a UV-VIS spectrophotometer was used to detect the absorbance at 765 nm.

2.4.2. Determination of Total Flavonoid Content

The total flavonoid content of each rice samples was measured using colorimetric method with some modifications in the methodology described by Fattahi *et al.,* (2014) [17]. 10 mg of the sample was dissolved in 10ml of methanol. After that, aliquots of the produced solution were taken at concentrations of 0.1, 0.2, 0.3, 0.4, and 0.5 µg/ml after 1 ml of the solution was dissolved in 10 ml of distilled water. After that, 0.3 ml of 5% NaNO3 was added. 0.3 ml of 10% AlCl3 was added after 5 minutes, and the mixture was incubated for 6 minutes. Two milliliters of 1M NaOH were then added to the mixture. At 510 nm, the absorbance was measured in relation to a blank. The qurecetin standard calibration curve was used to determine the total flavonoid content.

2.4.3. Determination of Amylose Content

The amylose content (AC) was measured using the colorimetric method described by Juliano *et al.*, (1971) [18]. 100 mg of samples were finely grounded and dissolved in 1 mL of 95% ethanol and 9ml of 1N NaOH in a tube. After 15 min of incubation in a boiling water bath, 100 ml of distilled water was added to the tubes. 5 mL of aliquot, 1 mL of 1 N acetic acid, and 2 mL of 0.2% iodine solution were added to another 100 mL volumetric flask, which was then placed in the dark for 20 minutes. Using a standard curve made from potato amylase, the absorbance was measured at 620 nm, and AC was computed.

2.4.4. Determination of Total Starch Content

Total starch content (TSC) was estimated as per the method described by Krishnan *et al.*, (2020) [19]. Samples weighing 100 mg were finely ground. Hot 80% ethanol was used twice to extract the starch. Following that, 6.5 mL of 52% perchloric acid and 5 mL of distilled water were used to treat the residue. At 25°C, the mixture was centrifuged for ten minutes. Following centrifugation, 100 mL of the final volume was prepared using distilled water, and the supernatant was collected. Absorbance was measured at 620 nm after an appropriate sample was treated with 5 mL of anthrone (0.2%) reagent. Using a glucose standard curve, TSC was computed.

3. Result

Eleven different varieties of rice (Ranjit, Bahadur sub-1, Natun aijong, Phul pakhri, Chapar aijong, Ranjit sub1, Geda gedi, Lalpeda, Kola mota, Lalpan, Rupahi) (Fig. 1) were collected from Dhubri districts of Assam

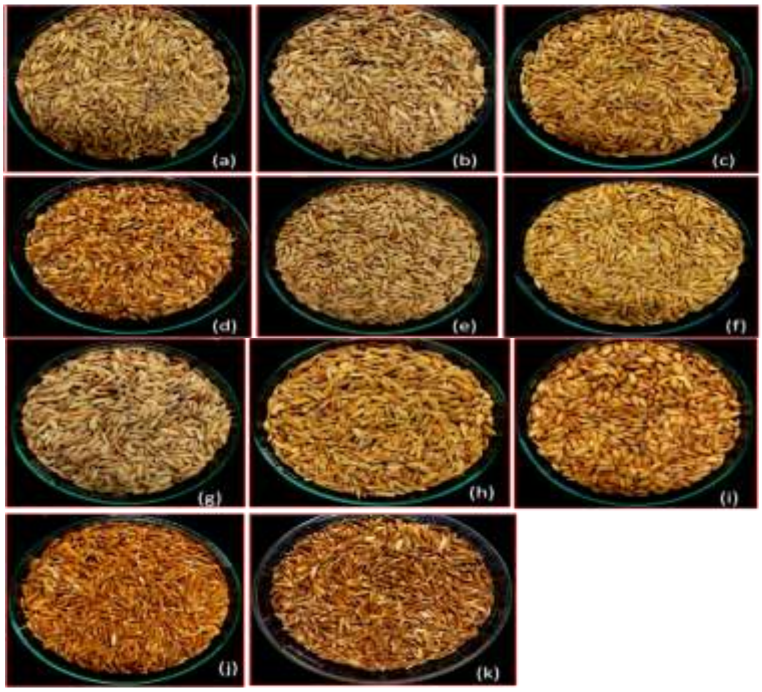

Fig.I: Collected rice varieties for the study (a) Ranjit, (b) Bahadur sub-1 (c) Natun aijon, (d) Phul pakhri (e) Chapar aijong (f) Ranjit sub-1 (g) Geda gedi (h) Lalpeda (i) Kola mota (j) Lalpan (k) Rupahi.

3.1. Proximate Analysis:

Proximate analysis including fat, crude fibre, protein, carbohydrate and food energy of different varieties rice is depicted in Table 2. There were notable differences in the rice varieties fat contents. Among the samples analysed, Lalpan Variety exhibited the highest fat content with a value of 4% and the lowest value for fat content was observed in Phul Pakhri with a value of 2.73%. The crude fiber content of several rice types, which range greatly from one another, is displayed in Table 2. Kola mota variety exhibited highest percentage of crude fiber with value 2.80% and Ranjit showed lowest percentage of crude fiber with 1%. Similarly, the rice varieties show different percentage of protein content, among them Bahadur Sub-1 had the highest protein content of 13.77% and Ranjit Sub1 and Chapar aijong, Phul pakhri had a significantly higher content of protein 13.03%, 12.08%, 11.39% respectively. In contrast, the lowest protein content was found in Lalpeda with value 5.56 %. Among all the studied variety Natun aijong had shown highest carbohrydrate content with value 86.54% and in contrast Lalpeda variety had shown lowest carbohydrate content with value 70.40%. Different rice varieties have shown different value of food energy content with highest value 412.1Kcal by Chapar Aijong, and lowest food energy shown by Lalpeda with value 332.91Kcal.

Rice Variety	Fat %	Crude fiber %	Protein %	Carbohydrate %	Food energy (Kcal)
Ranjit	3.06	1	9.45	82.17	394.02
Bahadur sub-1	2.80	2.60	13.77	80.57	402.56
Natun aijong	2.86	1.80	7.62	86.54	402.38
Phul pakhri	2.73	1.80	11.39	73.93	365.85
Chapar aijong	3.50	1.20	12.08	83.07	412.1
Ranjit sub1	3.73	1.30	13.03	72.37	375.17
Geda gedi	3.53	1.20	5.85	82.77	385.85
Lalpeda	3.23	1.60	5.56	70.40	332.91
Kola mota	3.40	2.80	9.5	75.53	370.72
Lalpan	4	1.80	5.78	75.87	362.6
Rupahi	3.40	2.00	6.42	86.00	400.28

Table II: Proximate composition of eleven different rice varieties.

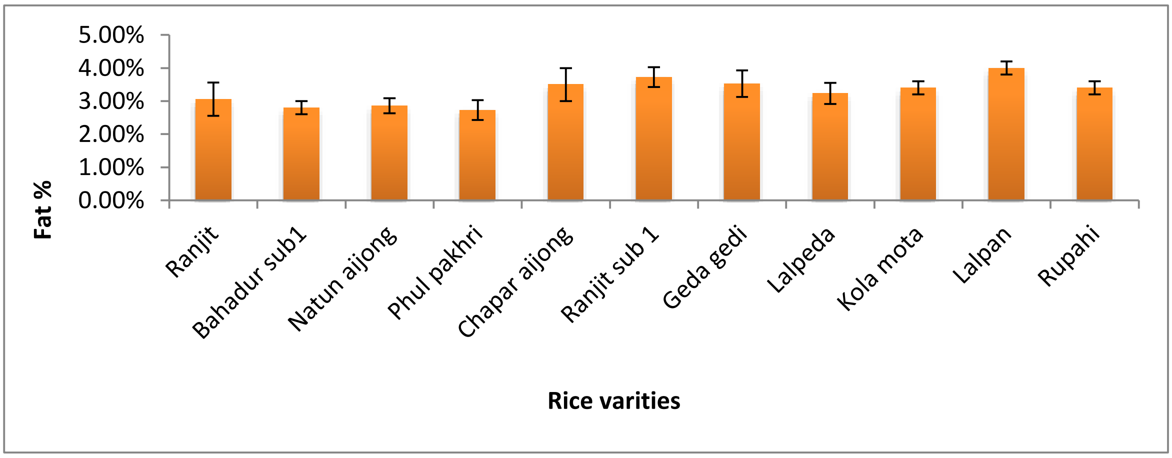

Fig II: Graphical representation of Fat content percentage of the studied rice varieties

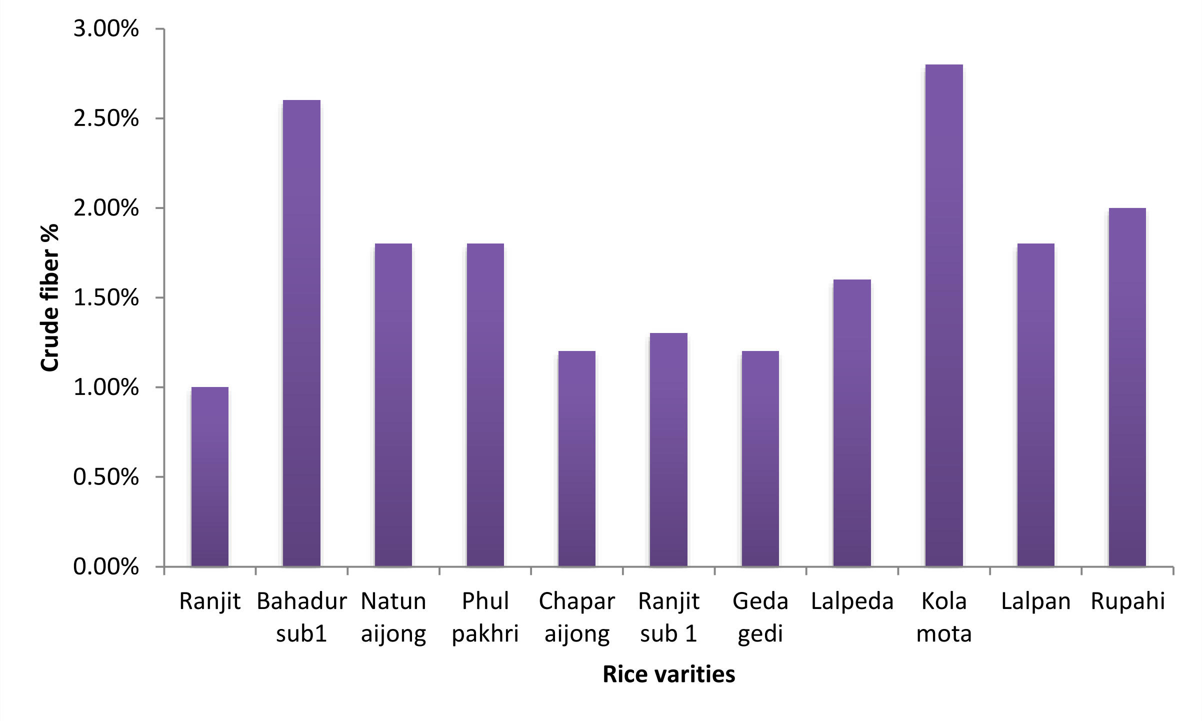

Fig III: Graphical representation of Crude fiber percentage of studied Variety

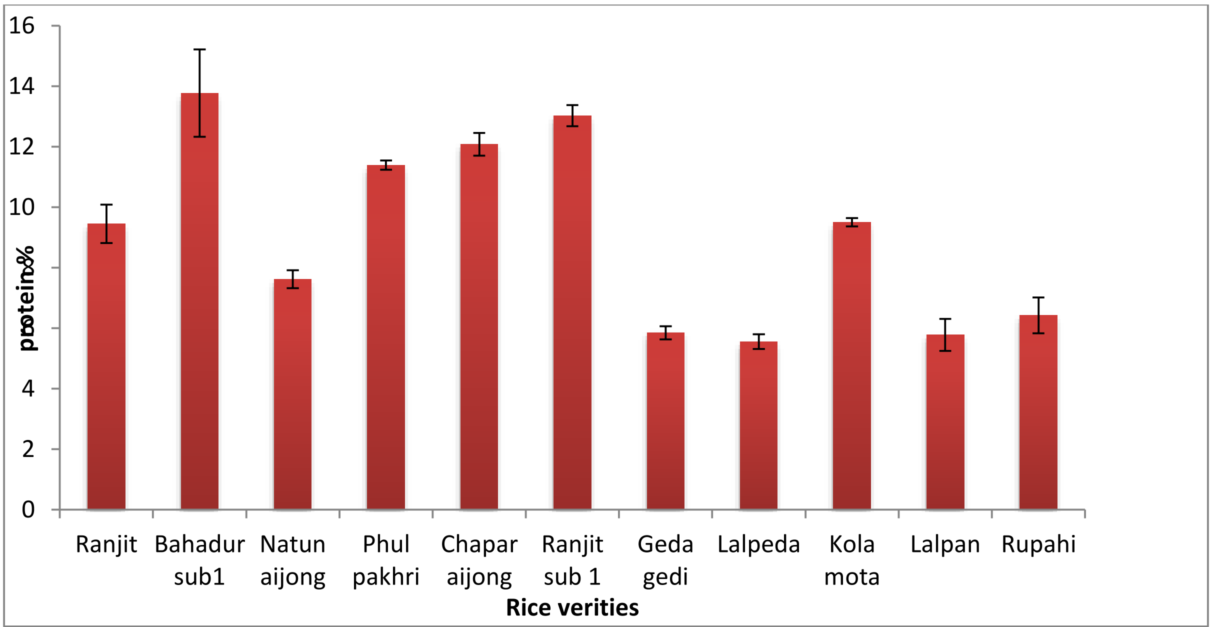

Fig IV: Graphical representation of Protein percentage of studied Variety

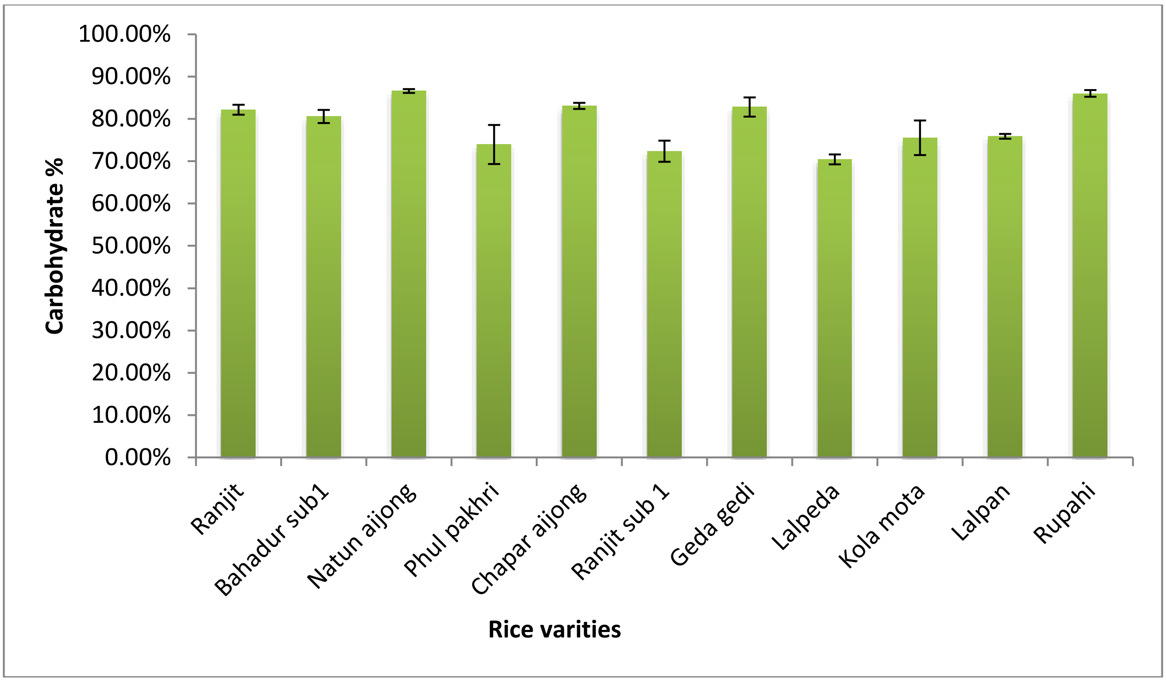

Fig V: Graphical representation of carbohydrate content of studied variety.

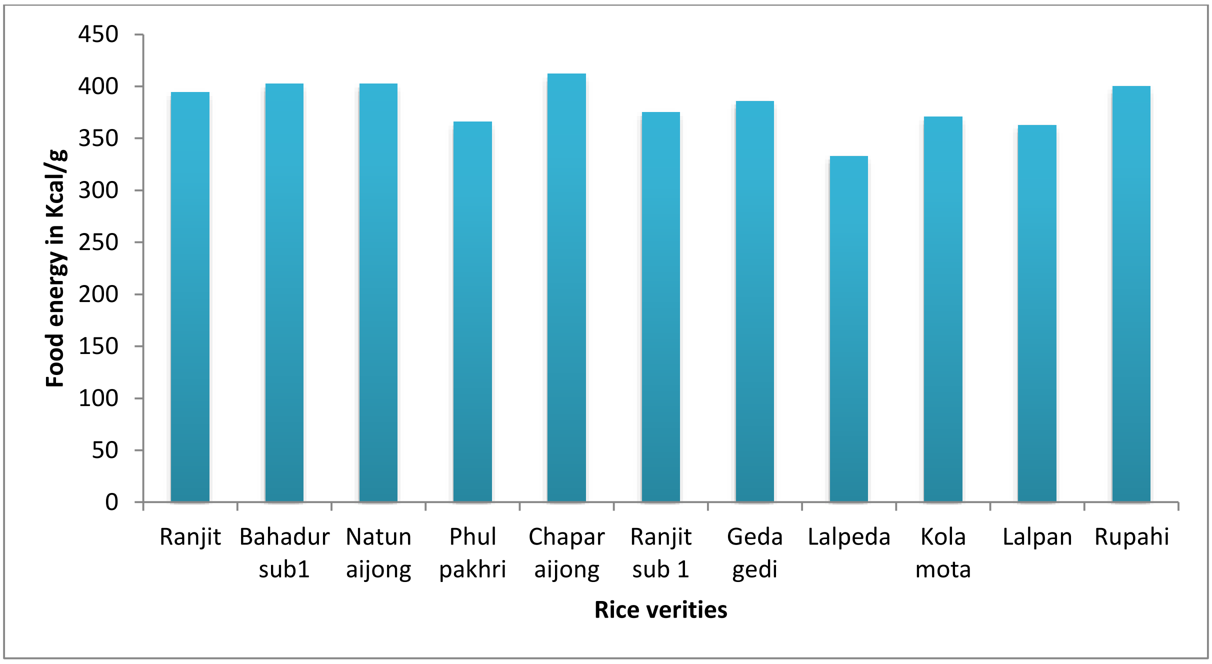

Fig VI: Graphical representation of Food energy content of studied variety.

3.1 Functional Properties of studied varieties of rice:

The functional properties of rice describe the relationship between the structure, content and molecular arrangement of food components along with the type of environment in which they are measured and associated. Their chemical, physical, and organoleptic qualities establish their functional features, which provide useful information for industrial applications. Swelling Power (SP), Oil Absorption Index (OAI), Water Absorption Index (WAI), and Water Solubility Index (WSI) were examined under functional properties.

3.1.1 Water Absorption Index (WAI):

WAI of different rice varieties showed significant difference as mentioned in Table 2. At 1.2506 g/L, Lalpeda's water absorption capacity was greater than that of the other types. Ranjit, however, had a lower WAI, measuring 0.8873g/L.

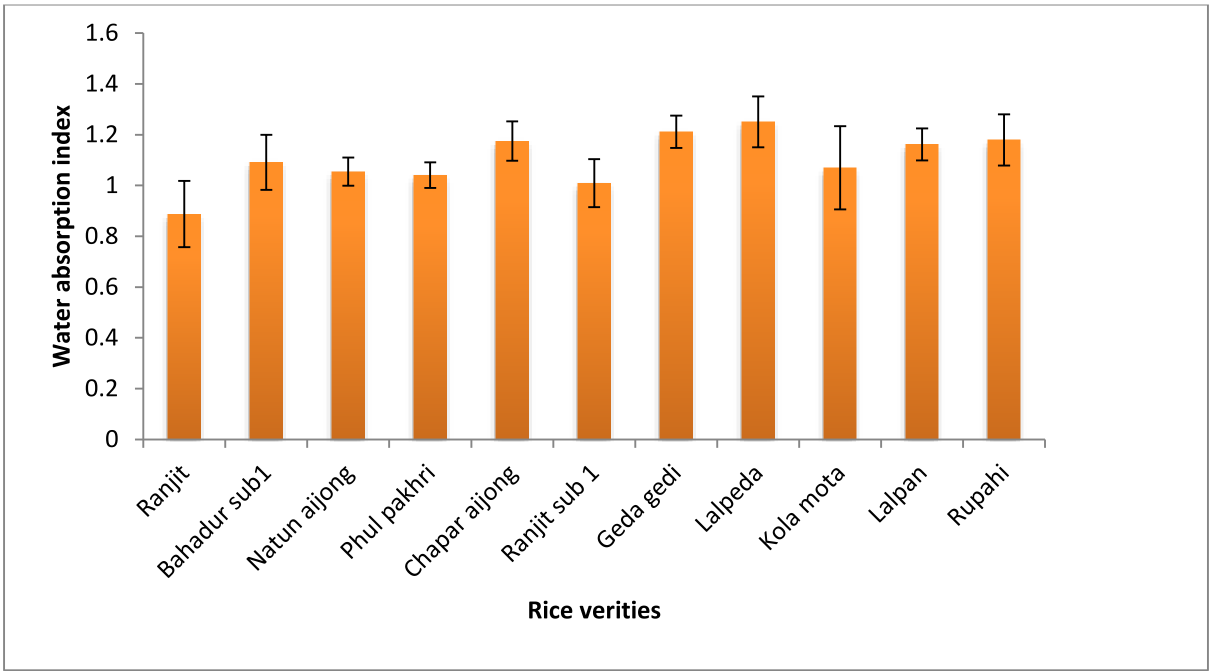

Fig VII: Graphical representation of Water Absorption Index content of studied variety.

3.2.2. Water Solubility Index (WSI):

WSI of different rice varieties showed significant difference (Table 2). Lalpeda with value 0.0933g/L showed highest WSI among the studied variety. On the other hand, Phul pakhri showed the lowest water solubility index at 0.024 g/L.

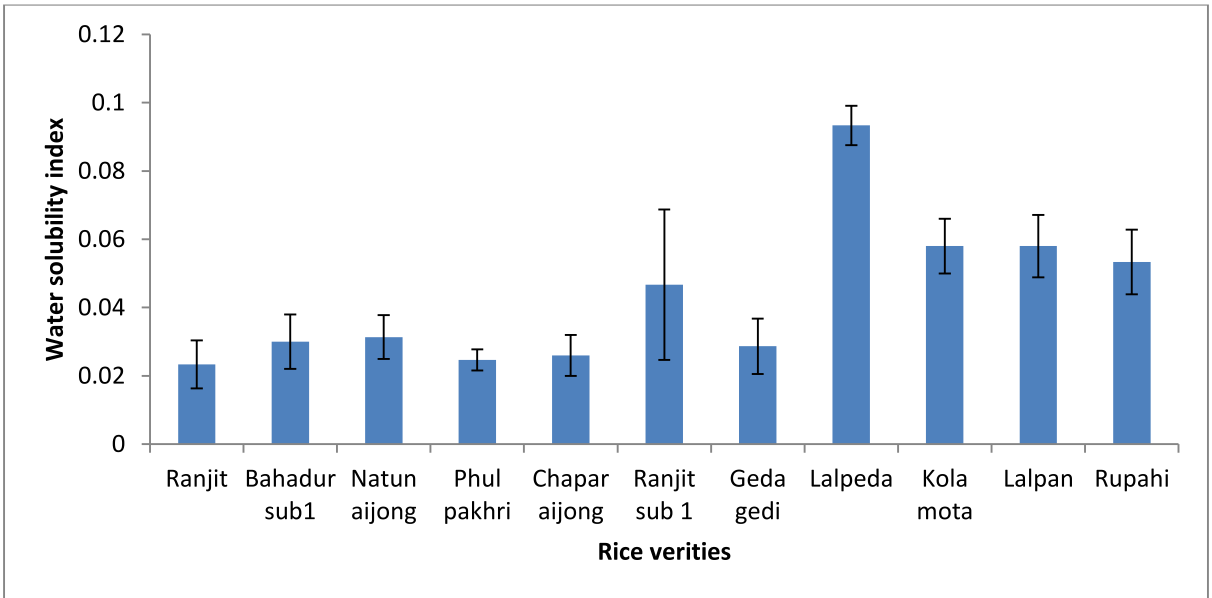

Fig VIII: Graphical representation of Water Solubility Index content of studied variety.

3.2.3. Swelling Power (SP):

Swelling power of different rice varieties showed differ significantly from each other (Table 2). Among the varieties, SP was highest in Gedagedi and Chapar Aijong with value 0.0114, 0.0113 respectively. Conversely, Ranjit showed the lowest swelling power at 0.0086.

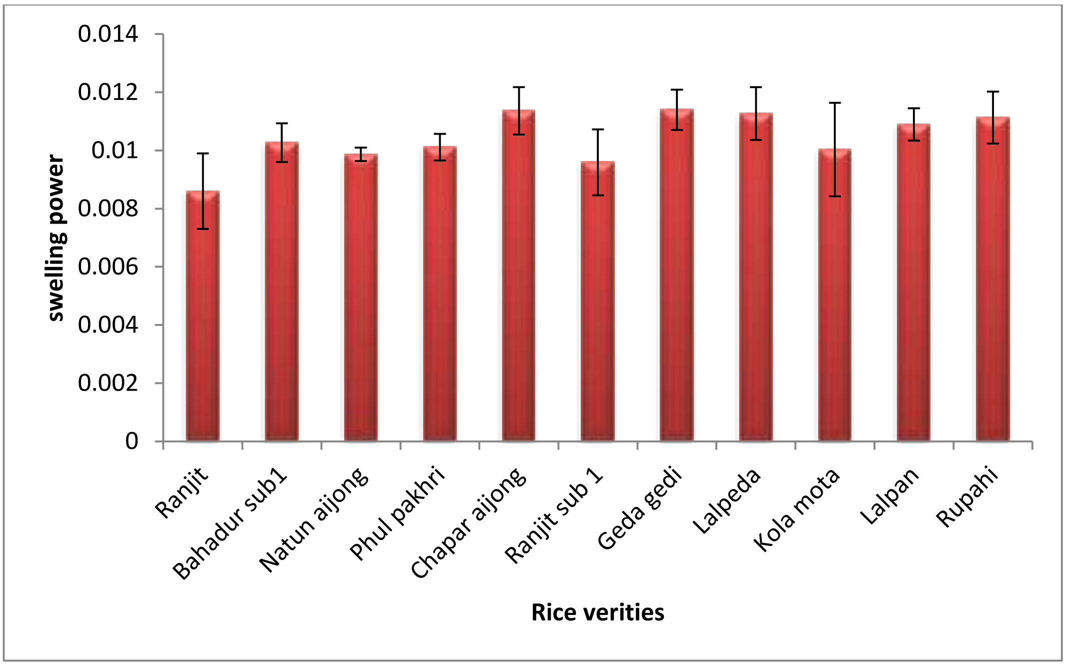

Fig IX: Graphical representation of Swelling Power (SP) content of studied variety.

3.2.4. Oil Absorption Index (OAI):

The OAI was highest in Bahadur Sub-1 with a value of 0.348. In contrast, Chapar Aijong showed lowest Oil Absorption Index with value 0.275.

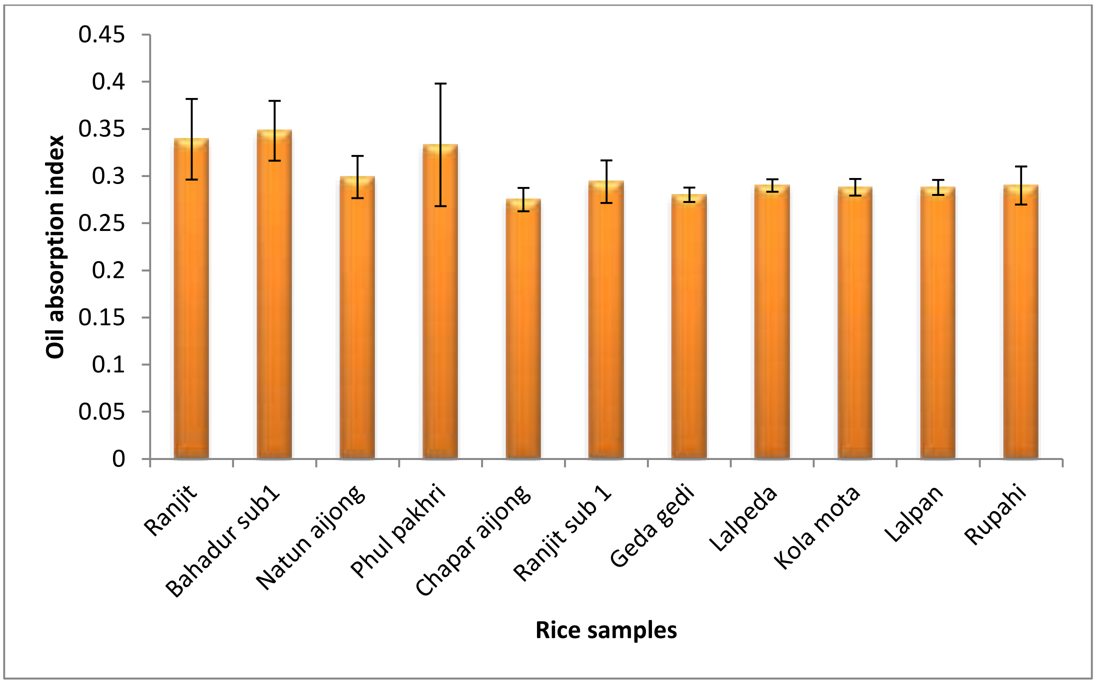

Fig X: Graphical representation of Oil absorption index (OAI) content of studied variety.

Rice Variety	WAI (g/L)	WSI (g/L)	SP	OAI
Ranjit	0.8873	0.0233	0.0086	0.339
Bahadur Sub-1	1.0906	0.03	0.0102	0.348
Natun Aijong	1.0546	0.031	0.0098	0.299
Phul pakhri	1.0406	0.024	0.0101	0.333
Chapar Aijong	1.1746	0.026	0.0113	0.275
Ranjit Sub-1	1.0093	0.046	0.0095	0.294
Geda gedi	1.2113	0.028	0.0114	0.28
Lalpeda	1.2506	0.093	0.0112	0.290
Kolamota	1.0693	0.058	0.0100	0.288
Lalpan	1.1613	0.058	0.0109	0.288
Rupahi	1.1793	0.053	0.0111	0.290

Table III: Functional composition of eleven different rice varieties

3.3. Biochemical Analysis:

3.3.1. Total Phenol Content (TPC):

In studied rice varieties the range of TPC varies from 0.001 to 0.002 µg/mg (Table 4). Among them Lalpeda showed highest TPC with value 0.0024 µg/mg and Bahadur Sub-1 showed lowest Total Phenolic Content with value 0.0016 µg/mg.

Rice varities	Total Phenol Content(µg/mg)
Ranjit	0.0018
Bahadur Sub-1	0.0016
Natun Aijong	0.0017
Phul Pakhri	0.0016
Chapar Aijong	0.0019
Ranjit sub-1	0.0017
Geda gedi	0.0019
Lalpeda	0.0021
Kola mota	0.0017
Lalpan	0.0020
Rupahi	0.0018

Table IV: Total phenol content of sample rice varieties

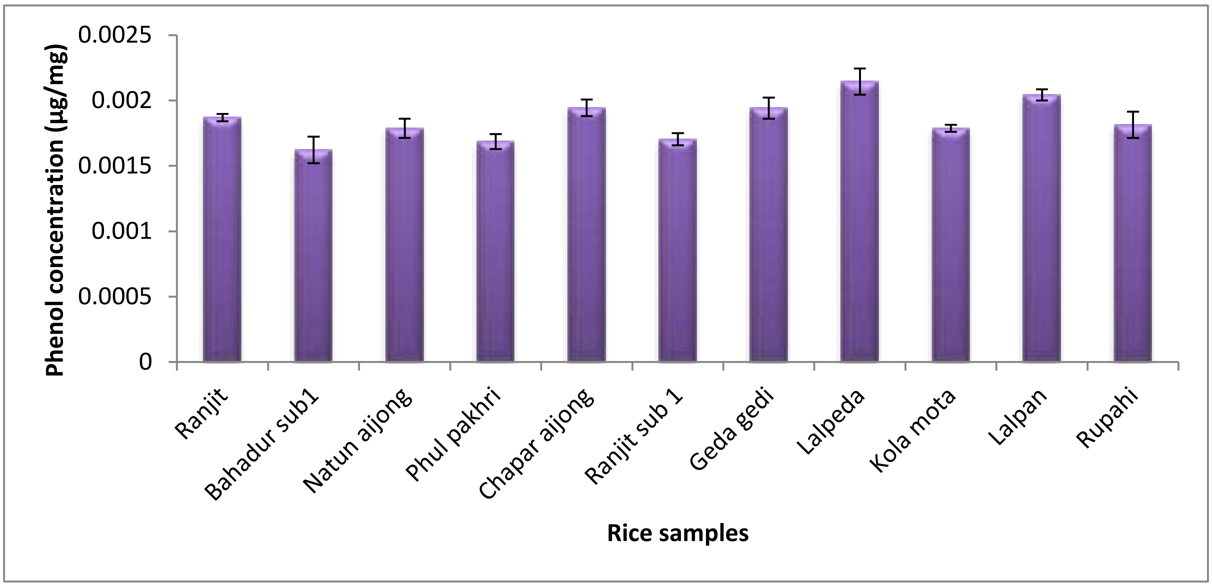

Fig XI: Graphical representation of Total Phenol content of studied variety

3.3.2. Total Flavonoid Content (TFC):

In the studied rice varieties, the range of TFC varies from 2.5 to 13.5 mg/g (Table 5). Among them Rupahi showed highest TFC with 13.59 mg/g and Natun Aijong showed lowest Total Flavonoid Content with value 2.72 mg/g.

Rice Varieties	Total Flavonoid Content(mg/g)
Ranjit	5.59
Bahadur Sub-1	2.74
Natun Aijong	2.72
Phul Pakhri	2.80
Chapar Aijong	2.81
Ranjit Sub-1	3.69
Geda gedi	4.52
Lalpeda	13.05
Kola mota	5.04
Lalpan	4.20
Rupahi	13.59

Table V: Total flavonoid content of sample rice varieties

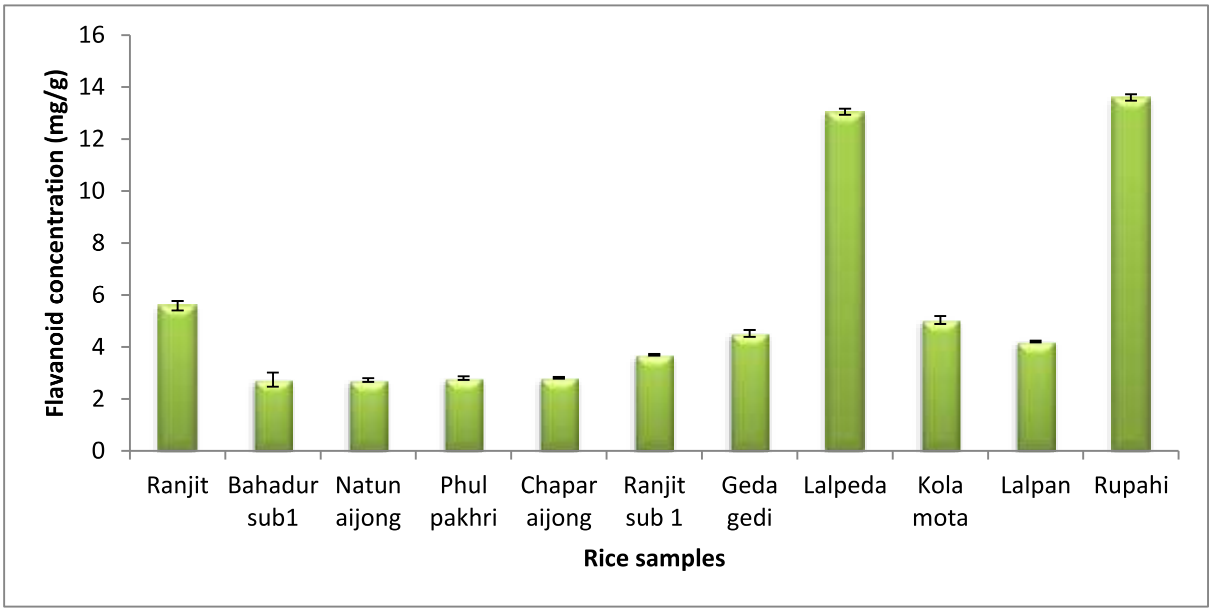

Fig XII: Graphical representation of Total Flavonoid Content of studied variety.

3.3.3. Amylose Content:

The amylose content of rice varies between 0 to 40% (Table 6). Among studied variety Rupahi had showed highest amylase content with value 18.76% and in contrast Ranjit had showed lowest amylase content with value 4.37%.

Rice varieties	Amylose content (%)
Ranjit	4.37
Bahadur Sub-1	10.26
Natun Aijong	12.31
Phul Pakhri	18.60
Chapar Aijong	7.96
Ranjit Sub-1	7.43
Geda gedi	6.97
Lalpeda	17.55
Kola mota	11.24
Lalpan	9.75
Rupahi	18.76

Table VI: Amylose content of sample rice varieties

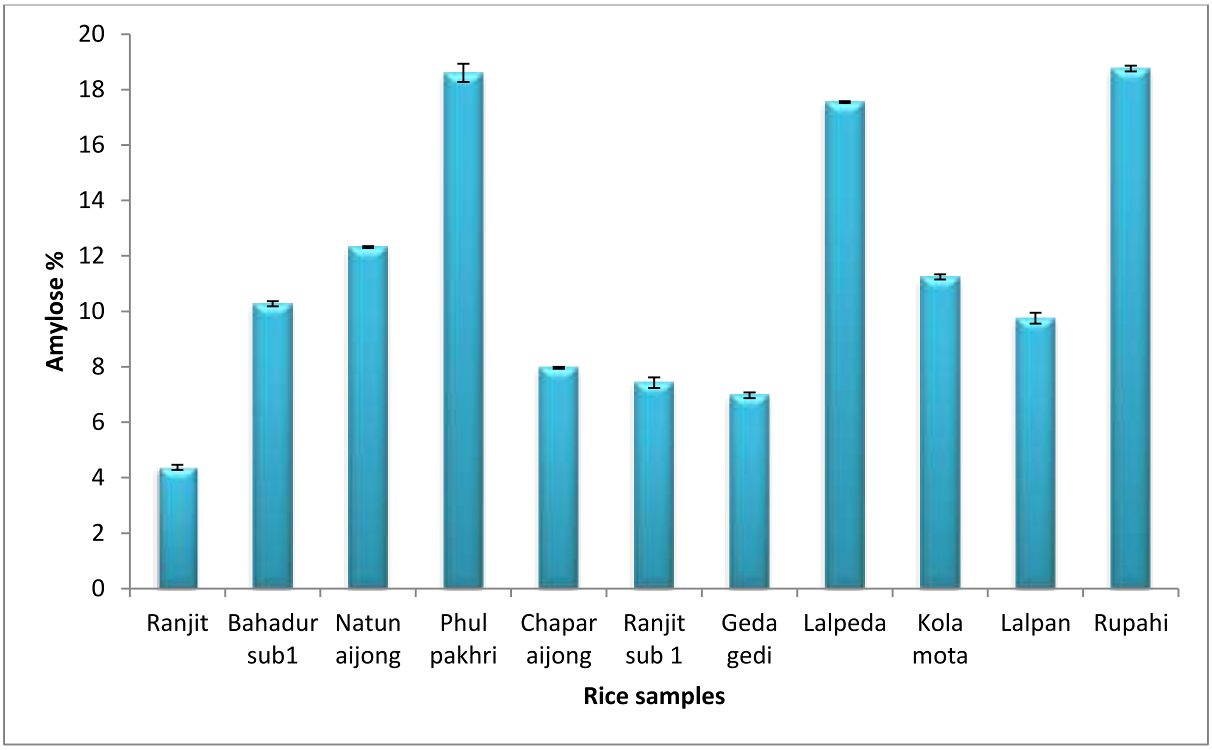

Fig XIII: Graphical representation of Amylose content of studied variety

3.3.4. Total Starch Content:

In the eleven studied rice varieties starch content varies from range 60 to 80% (Table 7). Among them Natun Aijong had showed the highest starch percentage with value 77.88 and Lalpeda had showed lowest starch percentage with value 63.36.

Rice Varieties	Starch Content (%)
Ranjit	73.95
Bahadur Sub-1	72.51
Natun Aijong	77.88
Phul Pakhri	66.54
Chapar Aijong	74.76
Ranjit Sub-1	65.13
Geda gedi	74.49
Lalpeda	63.36
Kola mota	67.98
Lalpan	68.28
Rupahi	77.4

Table VI: Starch content of sample rice varieties

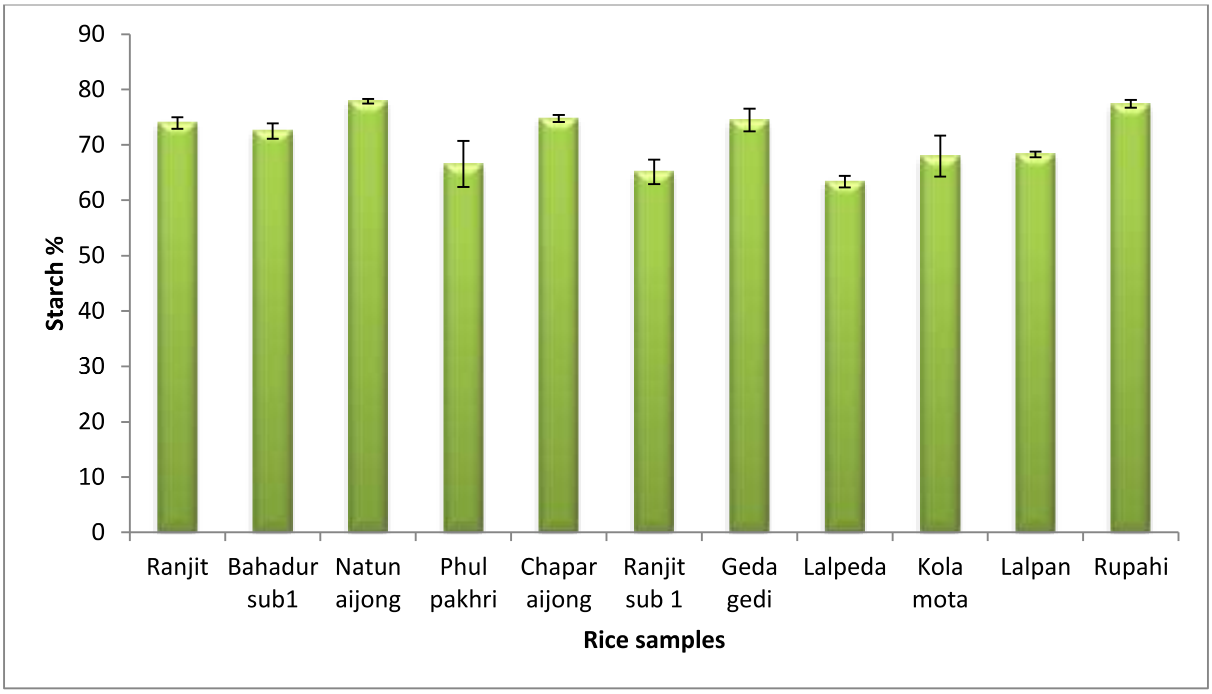

Fig XIV: Graphical representation of Starch content of studied variety.

4. Discussion

4.1. Proximate composition

The crude protein, crude fat, total mineral, crude fiber, carbohydrate, and energy content of the rice grains derived from this study are shown and discussed. The protein content of rice determines its nutritional value, and among cereals, rice has the lowest protein level. Consequently, the composition of amino acids determines the quality of protein. Because of its distinct essential amino acid composition, rice protein is superior. The study's crude protein level was often lower (1-2.80%) than what had been previously noted for polished rice varieties, which included 5.30 to 5.90% [20]. The present findings of protein content were showed different range (5.56 -13.77%) whereas Thomas *et al.*, (2013) found highest protein percentage in black rice was (8.16%) [21]. Chatterjee *et al.*, (2019) found mulagabhuru's protein percentage was 6.63%, while Bahadur's was 9.48%. [22]. The crude fat content analysis showed that the unpolished rice samples varied from 2.73% in Phul Pakhri to 4% in Lalpan. Compared to those documented in the literature, the results obtained were higher (0.57 to 0.85%) [23]. In contrast to the current examined varieties, Chatterjee et al. (2019) discovered that the crude fat percentage of polished rice samples ranged from 0.45% in Bahadur to 1.40% in Ranjit, while the crude fat content of unpolished rice samples ranged from 1.95% in Bahadur to 3.95% in Luit. It was discovered that the carbohydrate content ranged from 61.67±0.11g/100g in Luit to 70.00±0.07g/100g in Disang, whereas it ranged from 71.79±1.73g/100g in Luit to 79.18±0.28g/100g in Lachit in the polished samples, which is lower than studied varieties (70.40 – 86.54%). Chatterjee *et al.*, (2019) observed highest amount of crude fibre content in Ranjit 2.96±0.23g/100g, whereas lowest in TTB 404 (0.88±0.03g/100g). The range of crude fiber from 1.50 to 2.00% obtained by Oko *et al.*, (2012) were almost similar to the present study [24]. Chatterjee *et al.*, (2019) reported that the food energy content of rice samples ranged from 345.55±3.84 kcal/100g to 498.41±3.79 kcal/100g, which is nearly identical to the sample under study. According to Oko *et al.*, (2012), the energy content varied between 262.94 and 398.82 kcal/100g, which was determined to be rather comparable with the samples under study [24].

4.2. Functional Properties:

Functional properties of rice like WAI, WSI, SP and OAI play a crucial role in determining its application and utility in various food preparations. To find out the qualities of a novel food, the functional properties can be considered useful [24]. Lalpeda exhibited the highest water absorption index (1.25), indicating its ability to absorb water effectively, while Ranjit had the lowest value (0.88). The WAI of the experimented varieties were found to be similar with other workers like Kadan *et al.,* (2008), and Lahkar *et al.,* (2020) [25,26]. Borthakur *et al.,* (2023) observed Upendra Bora has a high capacity to absorb water with a value of 4.114 and the lowest Water Absorption Index was in Dudh Bora with a value of 1.944 which is higher than the present studied rice varieties (0.88-1.25) [27]. According to Borthakur *et al.,* (2023) WSI of Malbhog Bora showcased the highest value of 0.808, indicating its ability to dissolve well in water. On the other hand, Ghee Bora displayed the lowest water solubility index at 0.41 which is higher than the present studied rice varieties (0.023-0.09). According to Borthakur *et al.,* (2023) SP in Chakhaw P. Bora showed highest value which was 0.038. Conversely, Malbhog Bora exhibited the lowest swelling power at 0.006, which was lower than the present studied rice varieties (0.008-0.113). According to Borthakur *et al.,* (2023) Oil absorption index was highest in Aijung Bora with a value of 0.665 and lowest in Lakhimpuria bora with a value of 0.253, which was slightly similar to present studied rice varieties (0.275-0.348).

4.3. Biochemical Analysis:

Determination of total phenol content (TPC) and flavonoids content in rice landraces is important which influence the antioxidant properties, one of the essential parameters for the nutritional point of view. Lahkar et.al., (2020) observed TPC of rice landraces ranged between 0.00329µg GAE equivalent/1mg in Kola Kunkuni Joha and 0.00541µg GAE equivalent/mg in Kola Joha. Where in present study the TPC was recorded in the range of 0.00162-0.00214 µg GAE equivalent/mg [26]. Genotypes and environmental factors, such as moisture content, may have an impact on the variance of TPC in various rice varieties [28].

In 1g of rice methanolic extracts, the total flavonoid concentration in 11 experimental samples ranged from 2.72 mg quercetin to 13.59 mg quercetin equivalents. Using the calibration graph, the lowest total flavonoid content was 2.72 mg in Natun Aijong, followed by Bahadur Sub-1 (2.74 mg), and the highest was in Rupahi (13.59), which had a lower value than the flavonoid content, which was 7.21 mg in Basmati370, 7.59 mg in Joha Bora, and the highest in Krishna Joha and Keteki Joha (105.16 mg) [28].

The amylose content of brown and polished rice of twenty-one colored rice varieties of Assam ranged from 0.2-20.98% and 2.6-21.18%, respectively. According to International Rice Research Institute’s (IRRI) rice classification system, most of the studied varieties were categorized into very low (2-9%) and low amylose (10-20%) containing varieties. Analyzing the amylose content in different rice landraces is a crucial step in rice grain classification. In this study, almost all the tested rice was found to possess low amylose content, which could be attributed as all the tested rice landraces of Assam was superior quality. Rice with a moderate amylose percentage often had a fluffier texture, while rice with a low amylose content created shiny, sticky rice that would not expand and still coagulated at room temperature. Rice with a high amylose content would not generate sticky rice and may expand and harden when cooled [29]. The amylose content of various pigmented and non-pigmented aromatic rice was published by Saikia et al. (2012), and this value was similar to their findings [30]. Lahkar *et al.,* (2019) found that the amylose concentration was higher than the currently investigated rice types, with the highest value being 19.33% in Kola Kunkuni Joha and Kola tulsi Joha and the lowest being 15.0% in Boga Joga and Kon Joha.

However, the starch content of the experimental rice ranged from 63.36 to 77.88%, whereas the maximum starch concentration was discovered in Natun Aijong. This figure is similar to the one reported by Saikia *et al.*, (2012), who said that the starch content ranged from 63.19% to 72.60%.

5. Conclusion

In conclusion, this study provided a comprehensive understanding of the physical, functional, and nutritional characteristics of 11 different rice varieties. After investigating and analysing different properties, it was seen that all the rice varieties exhibited a good proportion of all the investigated properties. However, there are a few varieties that have revealed slight superior quality as compared to other varieties. These varieties include Rupahi, Bahadur Sub-1, Lalpeda, Geda gedi, Ranjit Sub-1, Natun Aijong. Among these varieties Ruapahi and Bahadur Sub-1 showed almost all the superior quality, which can be recognized as an ideal breeds. These findings contribute to the knowledge base of rice, facilitating the selection, utilization, and promotion of specific varieties based on their unique properties. Future research can build upon these findings to develop improved rice cultivars.

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