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Phyto-chemical and nutritional analysis of Deku and Itanagar indigenous rice cultivars consumed by the Adi tribes of Arunachal Pradesh, India

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Abstract

Deku and Itanagar are the two main indigenous rice cultivars, consumed by the Adi tribe of Arunachal Pradesh. An attempt was made to compile the phyto-chemical profile of these two rice cultivar to assess their nutritional and anti-nutritional components. The contents of reducing sugar, total carbohydrate, soluble protein, ascorbic acid, total phenols were higher in the Itanagar rice cultivar and cellulose, thiamine, Vitamin E, crude fibre, total free amino acid and free fatty acids along with phytic acid and tannins were higher in the Deku rice cultivar. The Deku rice cultivar was found to contain high anti-nutritional components such as phytic acid and tannins. Hence, it is concluded that the Itanagar rice cultivar was superior to the Deku rice cultivar.

Keywords: Adi tribes, Deku and Itanagar rice, free fatty acid, nutritional and anti- nutritional compounds, phytic acid, vitamins

Introduction

Rice (*Oryza sativa* L.) is a plant belonging to the family of grasses, Gramineae (Poaceae). Rice is associated with wet, humid climate, though it is not a tropical plant. It is believed as a descendent of wild grass that was most likely cultivated in the foothills of the far Eastern Himalayas. It takes on an important role in the socioeconomic life of the people in many regions of North East India. Rice has been regarded as the best staple food among all the cereals for more than 3 billion people constituting 50% population of the Earth [1]. It is the most popular staple food playing a pivotal role in food security of North Eastern region of India.

Rice is known as the grain of life as it provides the majority of starch, protein and micronutrients [2-4]. Rice occupies the principal position in a composite and varied variety of crops. The rice grain is the most rapidly growing source of food in Asia and has a major influence on food security all over the world and human nutrition [5]. Rice is also known as functional food because of its high digestibility of starch, high values of amino acids, high content of essential fatty acids, selenium and anti- hypertensive effect [6].

Arunachal Pradesh, a North Eastern state of India is considered as one of the biodiversity hot spot region. This state is blessed with many different varieties of rice and almost all the districts of Arunachal Pradesh cultivated rice as it is their main staple food (Table 1 & Fig. 1). Among different indigenous tribes, Adi tribe is a prominent tribe solely depending on rice for food. Adi people used rice not only for food, but also for preparation of indigenous alcoholic beverages like kala apong (local black beer), Apong (white beer), etc. They applied different methods for cooking rice to get to different ethnic foods of Adi tribe. Pinam, the ethnic cooked rice is prepared inside the bamboo shoot (Fig. 2A). Moistened rice grains are wrapped with special leaves called Akkam for burning in the fire after inserting inside the bamboo shoot and used as food by the Adi people. The cooked rice has special aroma as well as taste. The cooking of rice under steam after grinding the rice grains, moisten and wrapping with Akkam is another ethnic method used by the Adi people. The cooked rice is given the ethnic name, Etting, which resembles idli of southern India (Fig. 2B). There are many ethnicities of Adi tribes in cooking rice, but in the present study our concern is more towards the chemical scenario of the indigenous rice varieties because the long term use of starchy food grain may cause deleterious health problems among the people of Adi tribes.

Table 1: Area, production and productivity of rice in different district under different productivity groups in Arunachal Pradesh

| Sl. No. | Productivity Groups | No. of Districts | Area (Million ha.) | % of State's Rice Area | Production in Lakh Tonnes | % of State's Rice Production | Productivity (Kg/Ha.) | State |
|---------|---|------------------|--------------------|------------------------|---------------------------|------------------------------|-----------------------|--|
| 1 | High Productivity (> 2,500 Kg/Ha) | - | - | - | - | - | - | - |
| 2 | Medium Productivity (> 2,000-2,500 Kg/Ha) | - | - | - | - | - | - | - |
| 3 | Medium-Low Productivity (> 1,500-2,000 Kg/Ha) | 1 | 0.104 | 08.74 | 0.171 | 13.44 | 1,644 | East Siang |
| 4 | Low Productivity (1,000-1,500 Kg/Ha) | 6 | 0.644 | 54.12 | 0.774 | 60.85 | 1,202 | Tawang, Dibang Valley, Lohit, Changlang, East Kameng, West Siang |
| 5 | Very-Low Productivity (< 1,000 Kg/Ha) | 6 | 0.442 | 37.14 | 0.327 | 25.71 | 740 | Papumpare, West Kameng, Lower Subansiri, Upper Siang, Tirap, Upper Subansiri |
| | Total | 13 | 1.190 | 100.0% | 1.272 | 100.0% | 1,069 | |

(Source: PA-Table-02-Arunachal Pradesh. drdpat.bih.nic.in/PA-Table-02-Arunachal%20Pradesh.htm)

**Fig 1:** Map of Arunachal Pradesh**Fig 2(A, B).** (2A): Preparation of Ethnic cooked rice inside the bamboo shoot, (2B) The Ethnic cooked rice wrapped in Akkam leaves.

Materials and Methods

Experimental material

Indigenous rice cultivar of Deku (Fig. 3A, 3B) and Itanagar (Fig. 3C, 3D) were obtained from the local market of Pasighat Town, East Siang District of Arunachal Pradesh.



Fig 3 (A-D): Deku and Itanagar rice. (3A & 3B) Deku rice grains, (3C & 3D) Itanagar rice grains

Biochemical profiling

The nutritional profiles like total carbohydrate, total starch, reducing sugar, non-reducing sugar, cellulose, pectin, free fatty acid, total soluble protein, total free amino acid and Vitamins (Vit. C, Vit. E, Thiamine) of the two indigenous rice cultivars Deku and Itanagar were carried out. Estimation of total carbohydrate of the samples was carried out by the method given by Hodge and Hofreiter^[7]. Total Starch content was calculated by the method given by Thayumanavan and Sadasivam^[8]. Reducing sugar content was estimated from the rice cultivars by the method given by Somogyi^[9]. Crude fiber, cellulose and pectin contents of Deku and Itanagar rice cultivars were estimated by the method given by Sadasivam and Manickam^[10]. Free fatty acid content was estimated as per the method given by Cox and Pearson^[11]. Total soluble protein was calculated by the method given by Lowry^[12]. Total free amino acid estimation was carried out by the method given by Balasubramanian and Sadasivamin^[13]. The Vitamin C content of the rice cultivars were estimated by the method given by Jagota and Dani^[14]. Thiamine content was estimated by the method of Sadasivam and Manickam^[10]. Vitamin E content estimation was carried out with the help of the method given by Rosenberg^[15].

Biochemical components like total phenol, tannins and phytic acid were also calculated as per the methods described by Malik and Singh^[16], Schanderl^[17] and Wheeler & Ferrel^[18].

Result and Discussion

The comparative biochemical profiling of two indigenous rice cultivars Deku and Itanagar of Arunachal Pradesh, India was conducted to explore the biochemical constituents present for providing the correct choice of rice cultivar as per the life style of the people of the state especially Adi people. Rice is rich in various nutrients. The primary nutrients in rice are carbohydrates, protein, amino acids, minerals, and so on. The whole-grain rice contains unique types and amounts of some

phytochemicals such as the gamma-oryzanol and tocotrienol fractions^[19].

Sugar (carbohydrate) stimulates the release of serotonin a feel-good brain chemical. Sugar is also linked to obesity, heart disease, cancer, dementia and diabetes. The taste of sugar also makes us to feel calm and relaxed. Even though sugar has many nutritional advantages, but their higher level in the blood causes diabetes, a wide spreading disease among the tribal peoples of the region. In the present study, reducing sugar content was found to be higher in Itanagar (2.80g/100g) than in Deku rice cultivar (1.45g/100g) (Table 2, Fig 4). Our determination was quite dissimilar from the earlier finding of Smyth and Prescott^[20] and the difference found may be because of the differences in the cultivars used for studying. The content of total carbohydrate was also found to hold more in Itanagar (61.23 g/100g) than in the Deku cultivar (56.50 g/100g) (Table 2, Fig. 4). The contents of carbohydrate in both the cultivars were less than the content in white rice reported by de Pee^[21]. The decreased value may be because of the cultivars chosen for analysis or the environmental conditions. The carbohydrate level has a wide range of physiological effects in respect to the health, such as; it controls the blood glucose and insulin metabolism, cholesterol and triglyceride metabolism, bile acid dehydroxylation, provision of energy, protein glycosylation, etc.^[22-24].

A higher content of total soluble protein was found to be more in the Itanagar rice cultivar (14.68 g/100g) than to Deku rice cultivar (14.34g/100g) (Table 2, Fig. 4). The protein content in both the cultivars was higher than the mean content of protein in different rice hybrids reported by Babu *et al.*^[25]. The higher values of protein content in our cultivars may be because of the cultivars used for analyses as well as the influence of acidic soil condition of the region. It is well established that the proteins perform essential functions throughout the systems of the human body. Their long chains of amino acids are critically important for catalyzing chemical reactions, synthesizing and repairing DNA, responding to stimuli and providing structural support^[26, 27].

Cellulose, a complex carbohydrate was detected more in the cultivar of Deku (0.55 mg/100g) than in the Itanagar (0.41 mg/100g) (Table 2, Fig. 4). Earlier it was found that the Cellulose increases the peristaltic movement of the intestine and helps indigestion^[28]. The total free amino acid was estimated to be more in the Deku cultivar (0.37 mg/100g) than in the Itanagar cultivar (0.18 mg/100g) (Table 2, Fig. 4). It is well established that the amino acids are the building blocks of protein and muscle tissue. They also played a major role in the physiological processes relating to our energy recovery, brain function and in our quest for fat loss^[29, 30].

The Ascorbic acid (Vit. C) content was found to be more in the Itanagar rice cultivar (0.68 mg/100g) than in the Deku rice cultivar (0.53 mg/100g) (Table 2, Fig. 4) while, the thiamine content was more eminent in the Deku cultivar (18.47 mg/100g) than that in the Itanagar cultivar (3.33 mg/100g) (Table 2, Fig. 4). Vitamin C commonly known as ascorbic acid is an effective quencher of singlet oxygen and other free radicals. The thiamine content in the cultivars chosen for analysis is higher than the value reported in white rice by de Pee^[21]. The difference in values may be because of the cultivars chosen for analyses. The role of thiamine in regulation of metabolism, prevention of nerve damage, supporting a healthy cardiovascular system, induction of immunity, alcoholism treatment and prevention of brain and vision problems is well studied^[31-33].

Vitamin E was found to be (5.31 mg/100g) in Deku rice cultivar, while (3.40 mg/100g) in Itanagar cultivar (Table 2, Fig. 4). The content of Vitamin E was found to be lower than the values reported by Dipti *et al.* [19] in rice bran. The conflict in our finding may be because of the cultivars chosen for analysis. It is a fat soluble vitamin useful in balancing cholesterol level, fighting free radicals and preventing disease development. It was likewise really useful in restoring damaged skin, thickening hair, balancing hormones, improving vision, suppress cancer and improving effects of medical treatments [34-41]. Their deficiency symptom includes poor transmission of nerve impulses, muscle weakness and degradation of the retina that cause blindness [42-44].

It was found that the total phenol content was more in Itanagar rice cultivar (0.51 mg/100g) than that in the Deku rice cultivar (0.44 mg/100g) (Table 2, Fig. 4). The total phenol content in both the cultivars was found to be lower than the value obtained in rice bran by Kaur *et al.* [45]. Phenolic compounds which are usually known as polyphenols are secondary metabolites and ubiquitous in nature. These groups of phytochemical compounds have morphological and physiological importance in a plant's growth and reproduction as they protect the plant against pathogens and predators [46, 47]. Phenols are reported to have anti-inflammatory, antimicrobial, antithrombotic, etc. properties that are good for health [28].

Phytic acid and Tannin content were mentioned to be more in Deku rice cultivar (7.51 mg/100g & 0.25 mg/100g respectively) than that in the Itanagar rice cultivar (6.30 mg/100g & 0.071 mg/100g respectively) (Table 2, Fig. 4). The phytic acid content was found to be a great deal lesser than the capacity reported in rice bran by Kasim and Edwards [48] and Lehrfeld [49]. Tannins are a highly polymerized form of phenolics which have been thought to possess anti-nutritional properties. Similarly, Phytic acid is likewise thought to possess anti-nutritional properties. It is a common storage form of phosphorus in seeds and interferes with calcium and iron absorption. The chelating ability of phytic acid with nutritionally essential elements and the possibility

of interference with the proteolytic digestion are responsible for anti-nutritional activity [10].

Interestingly, the estimated crude fiber content was nearly equal in both the cultivars (5.45% & 5.0% Deku and Itanagar rice respectively) (Table 2, Fig. 4). The content of crude fibre reported in our study was somewhat higher than the values of crude fibre of different cultivars of rice reported by Oko and Ugwu [50]. Now a day's fiber is becoming one of the most appreciated ingredients in our daily diet [25]. Fiber offers variety of health benefits and is indispensable in reducing the danger of chronic disease such as diabetes, obesity, cardiovascular disease and diverticulitis [51].

Free fatty acid content was found to be very less in both the cultivars as 0.0009 mg/100g in Deku whereas 0.0007 mg/100g in the Itanagar rice cultivar (Table 2, Fig 4). Fatty acids are the building blocks of fats and lipids. Fatty acids are physiologically very important helping in the establishment of healthy cell membrane, proper development and functioning of the brain and nervous system, proper thyroid and adrenal activity, hormone production, regulation of blood pressure [52-55].

Table 2: Some Biochemical components of Indigenous rice varieties.

| Sl. No. | Biochemical components | Deku | SD | Itanagar | SD |
|---------|---------------------------------|--------|--------|----------|--------|
| 1. | Reducing sugar (g/100g) | 1.45 | 0.08 | 2.80 | 0.50 |
| 2. | Total carbohydrate (g/100 g) | 56.50 | 0.86 | 61.23 | 0.55 |
| 3. | Total soluble protein (g/100g) | 14.34 | 0.97 | 14.68 | 0.41 |
| 4. | Cellulose (mg/100g) | 0.55 | 0.18 | 0.41 | 0.15 |
| 5. | Total free amino acid (mg/100g) | 0.37 | 0.09 | 0.18 | 0.045 |
| 6. | Ascorbic acid(mg/100g) | 0.53 | 0.12 | 0.68 | 0.026 |
| 7. | Thiamine (mg/100g) | 18.47 | 0.71 | 3.33 | 0.42 |
| 8. | Vitamin E (mg/100g) | 5.31 | 0.44 | 3.40 | 0.51 |
| 9. | Total phenols (mg/100g) | 0.44 | 0.12 | 0.51 | 0.051 |
| 10. | Phytic acid (mg/100g) | 7.51 | 0.46 | 6.30 | 0.35 |
| 11. | Tannins (mg/100g) | 0.25 | 0.10 | 0.071 | 0.013 |
| 12. | Crude fiber (%) | 5.45 | 0.40 | 5.0 | 0.75 |
| 13. | Free fatty acid (mg/100g) | 0.0009 | 0.0001 | 0.0007 | 0.0002 |

SD, standard deviation

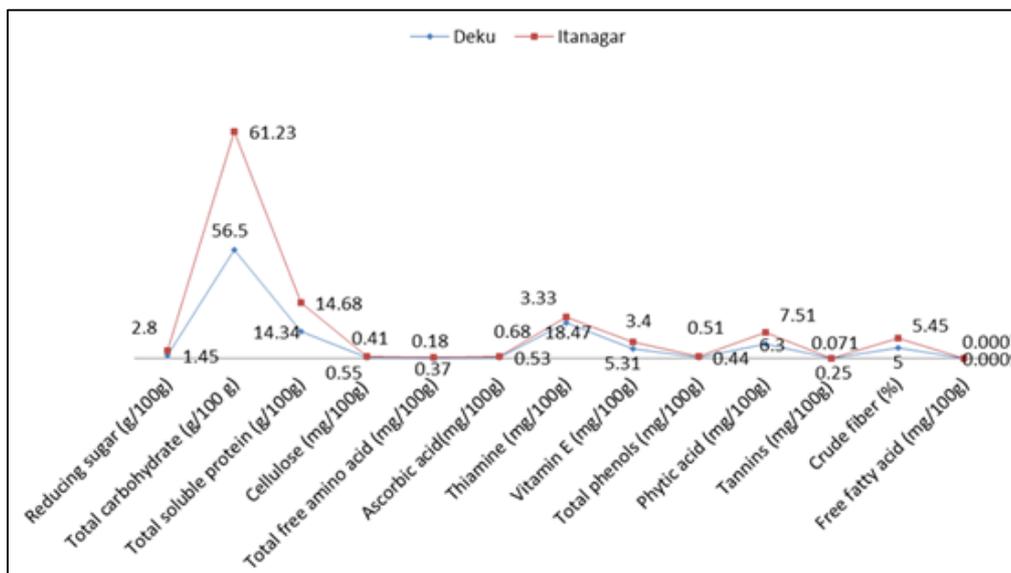


Fig 4: Graph values showing chemical components of Indigenous rice varieties Deku and Itanagar.

Conclusion

Arunachal Pradesh is blessed with many different indigenous tribes in which the Adi tribe is one of the prominent folks. These indigenous people are totally depending on rice for

their intellectual nourishment, not just for food but also for rice beverages. Therefore, it becomes very necessary to have the idea of the bio-chemical scenario of these rice cultivars as they consumed these two rice cultivars chiefly for their food

as well as for making other beverages. It has already been well established that having white rice daily can increase the risks of type 2 diabetes. With the shifting trends in living style of the Adi people it may be recommended to reduce the uptake of such cultivars of rice as it is starchy enough to cause type 2 diabetes.

Some of the nutritional and anti-nutritional components were analyzed and it is concluded that the Itanagar rice cultivar was superior to the Deku rice cultivar. Since, the Itanagar rice cultivar was bestowed with high nutritional contents of reducing sugar (2.80g/100g), total carbohydrate (61.23 g/100g), soluble protein (14.68 g/100g), ascorbic acid (0.68 mg/100g), total phenols (0.51 mg/100g) while, the Deku rice cultivar was reported to contain high cellulose (0.55 mg/100g), thiamine (18.47 mg/100g), Vitamin E (5.31 mg/100g), crude fibre (5.45%), total free amino acid (0.37 mg/100g) and free fatty acids (0.0009 mg/100g) along with anti-nutritional components phytic acid (7.51 mg/100g) and tannins (0.25 mg/100g).

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