Analysis and Identification of Chemical Content of Rice of Several Strains Local Upland Rice

Abstract

So far, Rice production has yet to meet domestic demand due to population growth, which continues to increase yearly. Lowland rice provides the most significant contribution to national rice production; for this reason, upland rice development is urgently needed to help increase national rice production. Central Sulawesi's upland rice germplasm is very abundant; it's just that there are still many that still need to be identified. For this reason, this study aims to identify the chemical levels of rice in several local upland rice lines. This research was conducted at the Research and Development Site of Gogo Rice, Faculty of Agriculture, Tadulako University is located at 230 meters above sea level in Kalama Hamlet III, Tamarenja Village, Sindue Tobata District, Donggala Regency, Central Sulawesi Province, with coordinates LS 00^{o}26'51.4 BT 119^{o}49'50,5. This research started from January to June 2023. This research was compiled using the Randomized Block Design (RAK) method with 14 local upland rice lines (Pae bohe, Menso, Maraki, Uva buya, Kalendeng, Pulau tau leru, Pulu Konta, Jahara, Buncaili, Delima, Pae dupa, Puyu tas, Tako, Dongan) and one variety of check (Situ bagendit) which was repeated three times to obtain 45 experimental units. The variables observed included moisture content, ash, protein, fat, carbohydrates, fibre and amylose. The results showed that the Pae dupa strain yielded a water content of 7.44%, protein content of 8.91%, fibre content of 3.90% and amylose content of 12.58%, while the Situ bagendit strain had a moisture content of 11.61%, ash content of 0.57%, protein content of 7.72%, fat content 0.66%.

Keywords: Rice, Chemical Content, Upland Rice

Introduction

Over half of the world's population utilizes rice (Oryza sativa) as their primary staple diet. It is an important crop for offering food security and livelihoods because to its nutritional value, economic importance, and cultural relevance. The need for rice as food for the Indonesian people has increased every year in line with the increase in population, which has increased every year [1], [2]. So far, rice production is still sourced from paddy fields, so there is a need for alternative land that can help increase national rice production.

Among the many varieties of rice, upland rice stands out as a robust selection that is suitable for cultivation in areas with scarce water supplies and difficult environmental circumstances. These upland rice is also suitable alternative to help increase national rice production.

The distinct environmental conditions under which upland rice is cultivated can influence its growth patterns and chemical composition. Despite the growing interest in the nutritional content of rice, studies specifically focusing on the chemical composition of various strains of local upland rice are limited. Upland rice grown in a tropical climate will have different growth patterns and chemical composition than upland rice grown in a temperate climate (Khush, 1995)

The germplasm of Center Sulawesi upland rice is very abundant; it is just that many have not been identified both in terms of morphological characters, physical quality, and chemical content contained in the rice [3]. The chemical content is essential to know, considering the diverse consumption patterns of Indonesians. Analysis of water, ash, protein, fat, carbohydrates, fiber, and amylose is critical to determining rice quality [4]. For this reason, research on the Analysis and Identification of the Chemical Content of Rice in Several Local Upland Rice Strains to identify the chemical content of rice in several local upland rice lines can be a source of information for the fulfillment of food needs for Indonesians.

Methods

This research was conducted at the Research and Development Site of Gogo Rice, Faculty of Agriculture, Tadulako University, in Kalama Hamlet III, Tamarenja Village, Sindue Tobata District, Donggala Regency, Central Sulawesi Province, with latitude LS 00o26'51.4 BT 119o 49'50.5, Tadulako University is located at an altitude of 230 meters above sea level in Kalama Hamlet III, Tamarenja Village, Sindue Tobata District, Donggala Regency, and Central Sulawesi Province. This research starts in January-June 2023.

Seeds of 15 local upland rice varieties (Pae bone, Menso, Maraki, Uva buy, Kalendeng, Pulu tau Peru, Pulu Konta, Jahara, Buncaili, Delima, Pae dupa, Puyu tas, Tako, Dongan and Situ Bagendit), collected from Indonesia, were used in the study.

The materials used in the study were herbicides (supremo and gremaxon), insecticides (spontaneous and regen), and pearl NPK fertilizer (16:16:16). The tools used in the research included hoes, machetes, a hand sprayer, a camera, a tape measure, plinth, and stationery.

This study was compiled using a Randomized Block Design (RBD) method with 14 local upland rice lines and one check variety repeated three times to obtain 45 experimental units.

The moisture content of rice was determined as described by gravimetric methods (AOAC, 1995) using a laboratory drying oven. The crude protein content was estimated from the nitrogen content of rice flour by using micro-Kjeldahl (AOAC, 1995) with a conversion factor of 5.95. Ash and crude fiber content of brown rice flours were determined according to AOAC (1995). Ash content was measured after incineration at 550°C for 8 h. The crude fat content was analyzed gravimetrically by Soxhlet extraction with hexane as solvent. The carbohydrate content (estimated total carbohydrate content) was determined by the difference from the analysis of moisture, protein, fiber, ash, and fats. Amylose content was determined by measuring the blue color of iodine-binding amylose using a UV-Vis Spectrophotometer at 620 nm by taking 100-mg rice flour sample. Total amylose content was determined from a standard calibration curve constructed from standard amylose.

Moisture Content (%) $=(Ws-(Wi+Wo))/(Ws) \times 100\%$
Information :
Ws = sample weight before baking (grams)
Wi = average sample weight + cup after baking (grams)
Wo = empty cup weight (grams)

Ash content $= (W1-W2)/(W) \times 100\%$
Information :
W = sample weight before incineration (grams)
W1 = sample weight + cup after ashing (grams)
W2 = empty cup weight (grams)

Protein Content (%) $=((X/1000) \times Y \times Fp)/W$ 100%
Information :
X = sample BSA concentration (ppm)
Y = volume (L)
Fp = dilution factor (if any)
W= sample weight (g)

Fat content $= (W1-W2)/(W) \times 100\%$
Information :
W = initial sample weight (grams)
W1 = pumpkin weight + sample after extraction (grams)
W2 = empty pumpkin weight (grams)

% carbohydrates = 100% - %(protein + fat + ash + water)
Carbohydrate content (%)$= (x \cdot Y.fp)/(W \times 1000) \times 100\%$
Where: X = glucose concentration (mg/L)
Y = Total Volume (L)
Fp = dilution factor (if any)
W= sample weight (g)

Fiber content $= (W1-W2)/(W) \times 100\%$
Information :
W = initial sample weight (grams)
W1 = weight of filter paper + residue after drying (grams)
W2 = weight of filter paper (gram)

Amylose Content (%)$= ((x). Y .fp)/((W .1000)) \times 100\%$
Where: X = amylose concentration (mg/L)
Y = Total Volume (L)
Fp = dilution factor (if any)
W= sample weight (g)

The obtained data were examined using the STAT Version 8 program, first with an analysis of variance to establish how the strains affected the observed features and then with a HSD (Honest Significant Difference Test) at a 5% threshold to identify the variations between each strain.

Results and Discussion

The eight strains utilized significantly impacted the amount of moisture, ash, fat, carbs, crude fiber, and amylose but not the amount of protein, according to the analysis of variance.

Table 1. The average value of chemical analysis of several local upland rice lines

Lines	Average value			
	Water content (%)	Ash content (%)	Protein content (%)	Fat content (%)
Pae Bohe	13.15 ^{A}	0.89 ^{G}	9.44 2	1.18 ^{HIJ}
Menso	12.61 ^{A}	1.07 ^{E}	8.39 11	1.31 ^{GHI}
Maraki	12.20 ^{A}	1.53 ^{B}	9.66 1	2.28 ^{A}
Uva Buya	12.50 ^{A}	0.82 ^{H}	5.80 15	1.13 ^{IJ}
Kalendeng	11.95 ^{A}	0.84 ^{GH}	7.05 13	0.99 ^{J}
Pulu Tau Leru	13.54 ^{A}	1.18 ^{D}	6.62 14	1.84 ^{BCD}
Pulu Konta	13.05 ^{A}	0.96 ^{F}	8.98 7	1.81 ^{CD}
Jahara	12.36 ^{A}	1.50 ^{BC}	8.96 8	1.95 ^{BC}
Buncaili	12.52 ^{A}	1.43 ^{C}	9.17 3	1.66 ^{DE}
Delima	12.89 ^{A}	1.16 ^{D}	9.16 5	1.39 ^{FGHI}
Pae Dupa	7.44 ^{B}	1.67 ^{A}	8.90 9	2.10 ^{AB}
Puyu tas	12.08 ^{A}	0.87 ^{GH}	9.16 4	1.43 ^{EFGH}
Tako	11.75 ^{AB}	1.14 ^{D}	8.85 10	1.43 ^{EFG}
Dongan	10.76 ^{AB}	1.06 ^{E}	9.07 6	1.59 ^{DEF}
Situ bagendit	11.61 ^{AB}	0.57 ^{I}	7.72 12	0.66 ^{K}

Note: Numbers followed by the same letter (a, b, c) in the same column do not show a difference

HSD test results at a 5% level showed that the Pulu Tau Leru line had a higher rice water content (13.54%) but was not different from the Pae bone line (13.15%), Menso (12.61%), Maraki (12.20%), Uva buya (12.50%), Kalendeng (11.95%), Pulu Konta (13.05%), Jahara (12.36%), Buncaili (12.52%), Delima (12.89%), Puyu tas (12.08%), Tako (11.75%), Dongan (10.76%), and Situ bagendit (11.61%). Meanwhile, the Pae Dupa strain has a lower rice water content (7.44%) but is no different from the Tako, Dongan, and Situ bagendit lines.

The water content in rice causes physical and chemical changes and reduces its quality. The higher the water content in rice, the more quickly it spoils (quickly turns yellow and smells good) and cannot be stored for a long time [5]–[7]. Thus, the Pae Bohe, Menso, Maraki, Uva Buya, Kalendeng, Pulu Konta, Jahara, Buncaili, and Delima lines are lines whose rice cannot be stored for a long time. Whereas Pae dupa, Tako, Dongan, and Situ bagendit are strained, whose rice can be stored for a long time.

The Pae dupa strain had a higher ash content (1.67%) than the other strains, while the Situ bagendit strain had a lower ash content (0.57%) than the other strains. The ash content of rice reflects the mineral content contained therein; the higher the ash content value in rice, the more rice has mineral content; conversely, the lower the ash content contained in rice, the less mineral content it contains.

Based on this, the Pae Dupa strain has more mineral content than the other strains, while the Situ bagendit strain has less mineral content. The higher the ash content, the worse the quality of the rice. The results of the study [8] indicated that the Puy, Ikang, and Krayan varieties had a low mineral content of 0.40%, 0.42%, and 0.41%, while the Keladi variety had a higher mineral content of 0.91%.

The high ash content in the Pae Bohe strains could be due to the protective layer of rice still present on the rice or the presence of contaminants from the rice hulls, which are difficult to separate during the rice milling process. The results of the study [9] There is a lot of ash/minerals in the bran layer of grain.

The results of the 15 strains had no significant effect on the observed variables of protein content, meaning that the protein content in rice from the 15 lines was the same. However, there was a tendency for the highest protein content to be found in the Maraki line (9.66%), followed by the Pae bone line (9.44%), Buncaili (9.17%), Puyutas (9.16%), Delima (9.16%), Dongan (9.07%), Pulu konta (8.98%), Jahara (8.96%), Pae dupa (8.90%), Tako (8.85%), Menso (8.39%), Situ bagendit (7.72%), Kalendeng (7.05%), Pulu Tau Leru (6.62%) and Uva Buya (5.80%).

Protein is one of the most important macronutrients for the body because protein is involved in formation of biomolecules. Most of the protein is formed from nitrogen elements provided by fertilization, even though it is absorbed from nature (Cornejo & Rosell, 2015; Kamsiati et al., 2016). This caused the 15 strains studied to show no significant effect on the protein content of rice. The results of research by Lestari et al., 2018 suggested that the protein content of Solok rice was 8.79% organic, 8.15% conventional, 8.50% organic, and 8.25% conventional.
8.50%, and conventional sokan 8.25%.

The Maraki strain had a higher fat content (2.28%) than the other strains, but it was not different from the Pae dupa strain (2.10%). Meanwhile, the Situ bagendit strain has a lower fat content (0.66%) than the other 14 strains.

Fat content is one of the determinants of the quality of rice. High-fat content results in a significant decrease in quality because the high-fat content in rice will be easily oxidized so that the rice gives off a rancid aromaand spoils more quickly. Thus, the Situ Bagendit rice line suffers damage longer than the other 14 lines, and the Maraki and Pae incense lines suffer damage more quickly.

The results of the research by Kamsiati et al., 2018 show that the Siam Unus variety is damaged more slowly because it has a low-fat content of 0.32%, while the Rantul variety is damaged more quickly because it has a higher fat content of 0.62%.

Table 2 : The average value of chemical analysis of Carbohydrate, Coarse and Amylose content of several local upland rice lines

Lines	Average value		
	Carbohydrate content (%)	**Coarse Fiber (%)**	**Amylose content (%)**
Pae Bohe	75.35^{E}	1.82^{DE}	24.41^{F}
Menso	76.61^{D}	1.92^{D}	14.51^{I}
Maraki	74.33^{F}	4.18^{A}	13.25^{J}
Uva Buya	79.75^{A}	1.99^{D}	27.58^{E}
Kalendeng	79.17^{AB}	1.16^{FG}	29.30^{C}
Pulu Tau Leru	76.82^{CD}	3.18^{B}	29.34^{C}
Pulu Konta	75.20^{EF}	2.79^{B}	28.17^{DE}
Jahara	75.24^{EF}	2.66^{BC}	28.68^{CD}
Buncaili	75.22^{EF}	2.05^{CD}	32.19^{A}
Delima	75.40^{E}	1.55^{DEF}	27.43^{E}
Pae Dupa	76.71^{CD}	3.90^{A}	12.58^{J}
Puyu tas	76.49^{D}	1.22^{EFG}	18.82^{H}
Tako	76.86^{CD}	0.82^{G}	21.85^{G}
Dongan	77.558^{C}	1.5080^{DEF}	30.702^{B}
Situ bagendit	78.495^{B}	1.6600^{DEF}	22.246^{G}

Note: Numbers followed by the same letter (A, B, C) in the same column do not show a difference

The results of the carbohydrate content test showed that the Uva buya (79.75%) and Kalendeng (79.17%) lines had higher carbohydrates than the other 13 lines. In comparison, the Maraki (74.33%), Pulu Konta (75.20%), Jahara (75.24%), and Buncaili (75.22%) had lower carbohydrate content than the other 11 strains. The carbohydrate content is the main component found in rice, most of which is starch. Carbohydrates serve as an energy source, and consuming carbohydrates can have a full effect.

The more carbohydrate content in rice, the more energy the rice produces. With this, the Uva Buya and Kalendeng strains are the best because they have higher carbohydrate levels than other strains. The results of research by [9] suggest that three times milling provides carbohydrates to white rice (83.57%), brown rice (84.07%), and black rice (80.67%). The results of Febriana research, et al., 2014 suggested that white rice flour has higher carbohydrates (34.45%) compared to brown rice flour (28.39%) and black rice flour (9.66%).

In the fiber content test, the Maraki (4.18%) and Pae dupa (3.90%) lines outperformed the other 13 strains, while the Kalendeng (1.16%), Puyutas (1.22%), and Tako (0.82%) lines underperformed the other 12 strains. White glutinous rice has 0.28% fiber, 76.24% carbs, 0.24% ash content, and 16.25% water content, according to Suriani's research findings from 2015.

The function of fiber is to provide a longer full effect because of its relatively long digestion. Thus the Maraki and Pae Dupa strains are very suitable for consumption because they can provide a long satiety effect. The research results by [11] suggest that organic black rice has a higher fiber content (7.70%) than other rice.

The results of the amylose content test showed that the Buncaili strain (32.19%) had the highest amylose content compared to the other 14 strains. The Maraki (13.25%) and Pae dupa (12.58%) lines had lower amylose content than the other 13 strains. The higher the amylose content in rice, the more perishable the rice produced. Conversely, the low amylose content in rice produces soft rice [12], [13]. Thus the Buncaili strain has the texture of pera rice, while the Maraki and Pae dupa strains have a soft rice texture.

The study's results [14] showed that high levels of amylose cause pandan Wangi rice to have the most complex texture when chewed or called para. The main parameter used to determine rice's cooking quality and taste quality is amylose. The results of the study [15] explained that the Batang Piaman variety includes high amylose rice (> 24%), medium amylose Ciherang rice (20-24%), and Memberamo rice is low amylose rice (<20%). High levels of amylose produce tender rice with a hard texture when cold, whereas those with low amylose content will produce fluffier rice with a soft texture.

Amylose levels are divided into three groups: high 25-30%, medium 20-24%, and low <20% [16]. Thus the Uva buya, Kalendeng, Pulu tau Peru, Pulu Konta, Jahara, Buncaili, Delima, and Dongan strains have high amylose content. The Pae bohe, Tako, and Situ bagendit strains had moderate amylose levels, and the Menso, Maraki, Pae dupa, and Puyutas strains had low amylose levels.

The research results by Samudin and Adelina, 2016 showed that there were 14 genotypes with moderate amylose levels and five with high amylose levels.

Conclusion

The Pae dupa and Situ bagendit lines were the best strains, where the Pae dupa lines produced 7.44% water content, 8.91% protein content, 3.90% fiber content, and 12.58% amylose content. The Situ Bagendit line had 11.61% water content, 0.57% ash content, protein content 7.72%, and fat content 0.66%.

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