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Comparative Quality Analysis of Hybrid and Traditional Rice Varieties under Different Storage Intervals

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ABSTRACT

The present study aims to evaluate the best rice varieties on the basis of their biochemical parameters that are affected by biochemical processes or insect infestations during the storage period through the different morphological, histological, and biochemical techniques and it may be helpful for providing the quality food and national food security as well as farmer's economically value also. The present investigation was carried out at the Department of Biochemistry, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.) from 2013 to 2015. The grains of different hybrid and traditional rice varieties were evaluated for various morphological, quality and biochemical characteristics under four-month storage intervals till the non-significance changes in their parameters. In this study, we selected a dry and cool place for the storage of rice grain that was placed in airtight containers. During the one-year storage (Different time intervals; 4 M (month), 8 M, and 12 M) of hybrid and traditional rice varieties, In hybrid rice, the minimum change in amylose content, ash content (total mineral), protein content, total sugar, reducing and non-reducing sugar content was recorded in traditional rice NDR 97 (9.836 %, 5.245%, 6.452%, 9.323%, 10.309% and 14.405% respectively) followed by traditional rice such as Narendralalmati and NDR 2064 and maximum change of amylose content, ash content, protein content, total sugar content, reducing sugar content and non-reducing sugar content was recorded in XRA 27934 (25.978%), KPH 466 (34.883%), XRA 27934 (16.267%), MEPH 113 (39.314%), KPH 466 (28.338%) and MEPH 113 (55.52%) respectively. During the histological observation, the most of traditional rice such as NDR-97, NDR-2064 had lower degradation than hybrid rice MEPH-113, Ankur-7042 and KPH-466.On the basis of morphological, histological, and biochemical studies of different hybrid rice and traditional rice varieties we can say that the Traditional rice variety NDR 97 and also other traditional rice varieties found superior over other rice varieties because it is a good source of protein, sugar, amylose and minerals. Hence, NDR 97 and other traditional rice varieties have the good keeping qualities, and food security which can open new vista for benefiting farmers and the high class of urban society of people and thus have enormous marketing potential in the domestic as well as global scenario.

Keywords: *Amylose, hybrid rice, protein, sugar, keeping quality, storage, SEM*

Introduction

Rice (*Oryza sativa* L.) is one of the most important foods consumed by half of the world's population(1). It contains 8-9% protein and it is the world's single most important food crop and primary food source for more than a third of the world's population(2). In recent few years, rice is the most important grain with regard tohuman nutrition and caloric intake, providing more than onefifth of the calories consumed worldwide by the human species(3). Rice is a dietary staple for more than half of the world's population (4)and accounts for more than 20% of caloric intake (5, 6).

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Rice ageing is a complicated process, which involves changes in physical and chemical properties of the rice grain. Starch, protein and lipids are the main rice grain components that affect cooking and eating quality. While the overall starch, protein and lipid contents in the rice grain remain essentially unchanged during storage, structural changes do occur. These changes affect the pasting and gel properties, flavour, and texture of cooked rice (7). Storing of rice is an important process that affects the quality of rice where the goal of storing is to provide optimum preservation of physiological and physical characteristics of grain (8)revealing that safe grain storage periods represent the maximum allowable number of days to store grain without major deterioration. Grain deterioration, which is usually expressed as a percent of dry matter loss, resulted in decreases in its value and quality. El-Dalil, 2017 (9) indicated that storage grains of Giza 179 rice cultivar for nine months gave the highest values for hulling (%), milling (%), broken (%), water uptake, cooking time, protein amylase and elongation. Jungtheerapanichet *al.*,2017 (10) indicated that increasing the storage period of paddy rice led to a decrease in breakdown grains and an increase in head rice yield. *For the storage of rice there are so many difficulties during storage such as insect and pest damage etc. but the most important thing is deterioration in biochemical and nutritional etc. So here biochemical and nutritional, keeping quality study of rice was studied during storage conditions.*

Materials and methods: The present investigation was carried out during kharif season 2013-15 at, Narendra Deva University of Agricultural and Technology, Kumarganj, Ayodhya, Uttar Pradesh. In this study, we selected five varieties of hybrid rice (Ankur 7042, XRA 27934, KPH 466, MEPH 113, Pusa RH 42) and traditional rice (Narendra Lalmati, Sarjoo 52, IR 64, Narendra 2064, Narendra 97) were collected from Crop Research Station, Masodha, Ayodhya and Department of Genetics and Plant Breeding, NDUAT, KumarganjAyodhya respectively. In this study, the rice seeds were stored in airtight containers select a dry and cool place for a year period. But we used one year aged rice for this study and study done by four-month intervals up to one year.

Histological study: Histological study was performed by SEM (scanning electron microscopy) in the Division of Entomology, ICAR-IARI, Pusa New Delhi. In these experiments, the fresh paddy seed, and rice seed and after the storage conditions were used. In the study of scanning electron microscopy aged seeds were treated with palladium coating for approximately 2 hours then it was used for the electron microscopy.

Amylose content (per cent): This method has been recommended by Juliano (1979) (11). In this method the colour intensity was measured by electronic-20 at 620 nm against a blank sample.

Ash content (g/100g): The ash content was estimated by the method described by Hart and Fisher (1971) (12) Ash content determination we used the muffle furnace. In this method, crucible with rice seed was finally placed into a muffle furnace which was maintained at 525-550°C (±2°C) for about 5-6 hours to destroy the organic matter of the sample. After expiry of period, the crucible was transferred to a desiccator for cooling without absorption of moisture by the ash. The cold ash along with silica crucible was weighed and the result was calculated and reported on the moisture free basis into per cent.

$$\text{Ash content (\%)} = \frac{\text{Weight of ash}}{\text{weight of sample}} \text{X100}$$

Extraction and estimation of total protein: 200 mg rice grains was ground in 1 ml of protein extraction buffer (100 mM potassium phosphate buffer, pH 7). The contents was transferred into centrifuge tube and centrifuged at 12,000 rpm for 20 min at 4°C and the supernatant was used for determining protein concentration and SDS-PAGE analysis. Total protein was estimated by the method of Lowry *et al.* (1951) (13)using Bovine Serum Albumin (fraction V, Sigma) as standard. The protein concentrations in the unknown samples were expressed as gram per dry weight of tissue.

Estimation of sugar content

Preparation of sugar extract: 10 ml of 50 per cent ethyl alcohol was added to 1.0 g of the well-ground kernel of rice grains and then centrifuged at 5000 rpm for 15-20 minutes. Supernatant was collected and evaporated on a hot plate until 2-3 ml of it remained. This was followed by the addition of 10 ml of CCl_4 and mixed well and left for 10 minutes. The content was transferred into a separatory funnel. After the addition of CCl_4, two layers were formed. The lower layer was discarded, while the upper layer was separated and 10 ml of distilled water was added to it. This was used as sugar extract for the estimation of both total and reducing sugars.

Total sugar estimation (g/100g): Total sugar was determined by the method of Dubois *et al.* (1956) (14) using phenol reagent. The intensity of colour was recorded at 480 nm by electronic-20. The calculation was done with the help of a standard glucose solution and results were expressed as grams per 100g of sample.

Reducing sugar (g/100g): Reducing sugar content of rice was determined by the method of Miller (1959) (15). 1 ml of sugar extract was mixed with 3 ml of dinitro-salicylic acid and kept over water bath for 10 minutes. The test tube was cooled at room temperature and the intensity of colour was recorded by spectronic-20 at 575 nm. The calculation was done with the help of standard curve prepared from standard glucose solution and results were expressed as grams per 100 g of sample.

Non reducing sugar content (g/100g): The non-reducing sugar was obtained by subtraction of reducing sugar from total sugar.

Non reducing sugar =Total sugar - reducing sugar

Results and Discussion

Histological study: Histological study of one year old rice grain was done by scanning electron microscopy (SEM). The most of traditional type rice such as NDR-97, NDR-2064 had low *deterioration* in comparison to hybrid rice (MEPH-113, Ankur-7042, KPH-466 *etc.*)(Figure 1 & Figure2).

Figures: Whole grain Fresh kernel Aged kernel

Ankur 7042 Ankur 7042 Ankur 7042

XRA 27934 XRA 27934 XRA 27934

KPH 466 KPH 466 KPH 466

MEPH 113 MEPH 113 MEPH 113

Pusa RH 42 Pusa RH 42 Pusa RH 42

NarendraLalmati NarendraLalmati NarendraLalmati

Fig. 1: Morphological observation of hybrid rice and traditional rice due to ageing

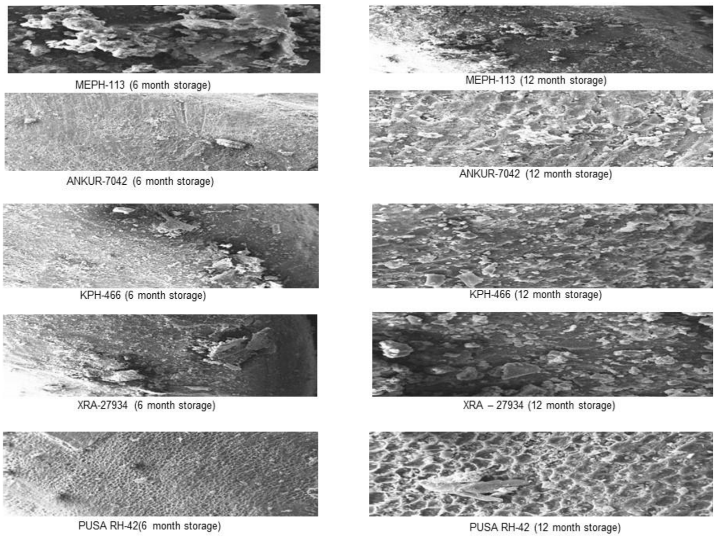

Fig. 2 (a): Scanning electron microscopy (micrograph) of hybrid rice under storage conditions (6 month and 12 month storage)

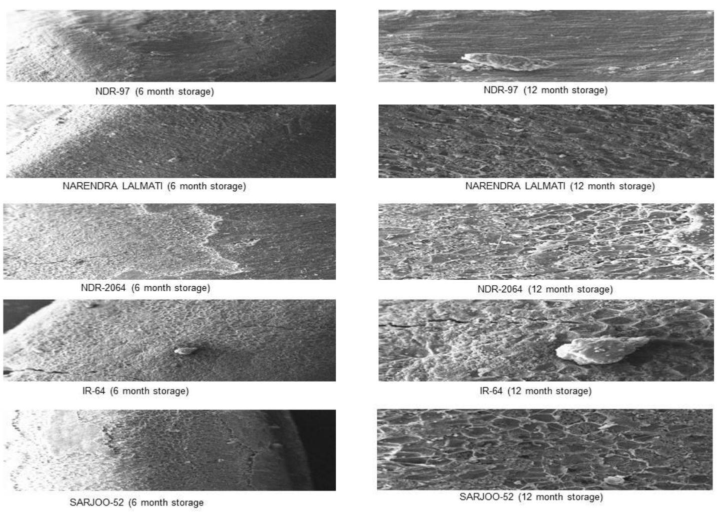

Fig. 2 (b): Scanning electron microscopy (micrograph) of traditional rice under storage conditions (6 month and 12 month storage)

SEM showed the high-resolution image and cleared the deterioration containing hybrid rice varieties. In previous study, a lot of degradation was observed on rice grain surface (16, 17).

Amylose content: After harvesting, At 0 days, the amylose content was recorded maximum in MEPH 113 (24.450 %) followed by KPH 466 (23.553 %) and the minimum was recorded in NDR 2064 (10.450 %).[Fig. 3] After 4 month storage, amylose content was recorded maximum in MEPH 113 (26.417 %) followed by XRA 27934 (26.392 %). After 8 month storage interval, maximum amylose content was recorded in MEPH 113 (28.738 %) followed by XRA 27934 (28.662 %). After 12 month interval, maximum amylose content was recorded in MEPH 113 (30.570 %) followed by KPH 466 (29.417 %). During the one year storage, the minimum change in amylose content was recorded 9.836 per-cent in NDR 97 followed by Narendralalmati (15.542 %) and the maximum increment was recorded 25.978 per-cent in XRA 27934 followed by NDR 2064. Change in amylose content may be closely correlated with sugar content, depletion in biochemical components, insect infestations, relative humidity, moisture content, amylase activity, pasting behavior hardness and gel consistency. There are so many of previous study were conducted on amylose content and the results have been found closely agree by previous research (18, 7, 19, 20).

Ash content: After harvesting the maximum ash content was recorded in IR-64 (1.663 g/100g) followed by Sarjoo-52 (1.540 g/100g) and the minimum was recorded in NDR-97 (0.877 g/100g). [Fig. 4] After the four-month interval maximum ash content was recorded in traditional rice IR 64 (1.533 g/100g) followed by Sarjoo 52 (1.470 g/100g) and minimum ash content was recorded in NDR 97 (0.861 g/100g). After the eight-month interval maximum ash content was recorded in traditional rice IR 64 (1.457 g/100g) followed by Sarjoo 52 (1.392 g/100g). After 12 month interval, maximum ash content was recorded in traditional rice Sarjoo 52 (1.352 g/100g) followed by IR 64 (1.327 g/100g). During one year storage, minimum change in ash content was recorded 5.245 per cent in traditional rice NDR-97 followed by Sarjoo 52 12.207 per cent.Change in ash content may be due to depletion in biochemical components such as protein content and amino acids, insect infestations, relative humidity, moisture content and the activity of lipooxygenase. The results was agreed by the previous research findings in which the depletion of ash contents correlated with amino acid contents (7, 21, 22).

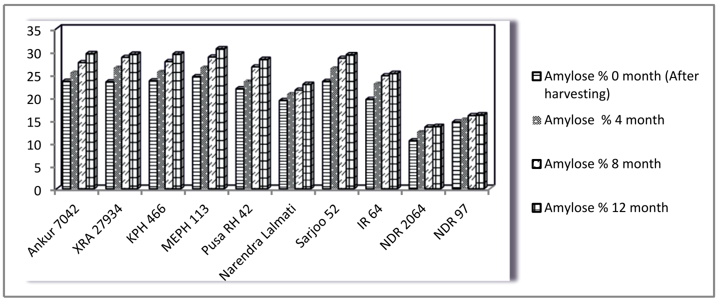

Fig. 3: Changes in amylose content of hybrid rice and traditional rice varieties under storage intervals

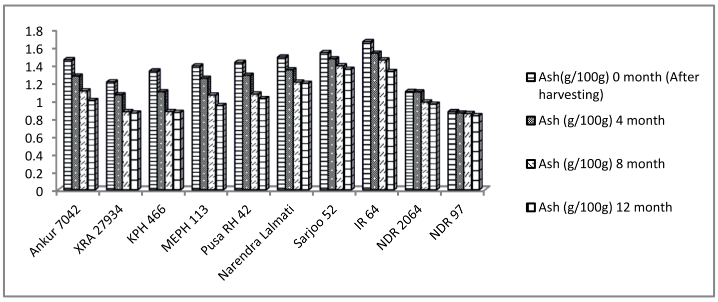

Fig. 4: Changes in ash content of hybrid rice and traditional rice varieties under storage intervals

Protein content: After harvesting the protein content was recorded as maximum in NDR 97 (9.082 %) followed by IR 64 (8.912 %) and minimum protein content was recorded in KPH 466 (6.450 %).[Fig. 5 and Table 1 & 2] After four month storage interval maximum protein content was recorded in NDR 97 (9.010 %) followed by NDR 2064 (8.450 %). After 8 and 12-month storage interval, the approximately the same results were observed. The decrease in protein content may be due to many factors such as an increase in the activity of protease, an ageing enzyme such as lipooxigenase, insect infestations, moisture content and relative humidity. The similar results were obtained in many previous research findings (7, 21, 22).

Table 1: Scoring of protein bands in traditional and hybrid rice after harvesting using SDS-PAGE

Varieties	Thick	Medium	Thin	Faint	Total
Narendralalmati	1	4	3	3	10
Sarjoo 52	1	4	2	4	11
IR 64	1	4	4	3	12
NDR 2064	1	4	4	2	11
NDR 97	1	4	4	3	12
Ankur 7042	1	4	2	3	10
XRA 27934	1	3	1	3	8
KPH 466	1	1	5	2	9
MEPH 113	1	2	3	4	10
Pusa PH 42	1	3	3	2	9

Table 2: Scoring of protein bands in traditional rice and hybrid rice after 12 month using SDS-PAGE

Varieties	Thick	Medium	Thin	Faint	Total
Narendralalmati	1	1	2	2	6
Sarjoo 52	0	2	3	2	7
IR 64	1	1	4	1	7
NDR 2064	1	2	3	2	8
NDR 97	1	3	3	1	8
Ankur 7042	1	1	3	3	8
XRA 27934	1	1	3	2	7
KPH 466	1	1	4	1	7
MEPH 113	1	2	2	2	7
Pusa PH 42	1	1	2	3	7

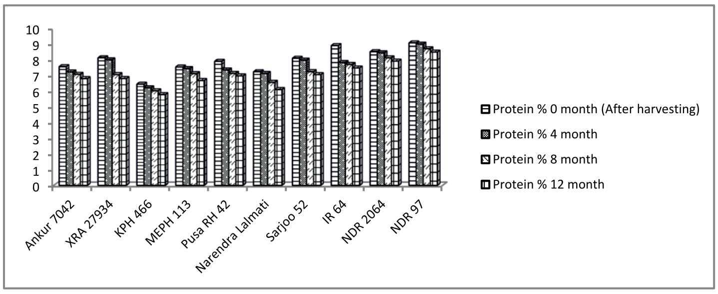

Fig. 5: Changes in protein content of hybrid rice and traditional rice varieties under storage intervals

Total sugar content: After harvesting, the maximum total sugar content was recorded in Narendra lalmati (1.636 g/100g) followed by Sarjoo 52 (1.463 g/100g) and KPH 466 (1.447 g/100g) and minimum total sugar content was recorded in IR 64 (1.112 g/100g). After 4, 8 and 12 month time interval, the superior rice varieties containing the maximum sugar contents were Narendralalmati, KPH 466, Sarjoo-52 and NDR-97 [Fig. 6]. During one year storage total sugar content was recorded minimum reduction in 9.323 per cent in NDR 97followed by NDR 2064 (10.955 %) and maximum changed in MEPH 113 (39.314 %). A decrease in total sugar content may be due to changes in lipooxigenase activity, protease activity, moisture content and also some antioxidant enzymes. A decrease in total sugar content during storage may also be affected by insect infestation. The results have close agreement with the many previous findings (7, 21, 22).

Reducing sugar: After harvesting, the reducing sugar was recorded maximum in Narendra lalmati (0.283 g/100g) followed by NDR 97 (0.261 g/100g) and Sarjoo 52 (0.237 g/100g) and minimum was recorded in IR 64 (0.121 g/100g)[Fig. 7]. After 4, 8 and 12 month time interval, similar results were obtained and the maximum sugar contents were observed in Narendra lalmati, KPH 466 MEPH 113 and NDR-97. During one year storage study the minimum change in reducing sugar content was recorded 10.309% in traditional rice variety NDR 97 followed by NDR 2064 (11.877 %) and the maximum change was recorded 28.338 % in hybrid rice variety KPH 466. The results were closely agreed with many previous findings (7, 21, 22). A decrease in total sugar content during storage may also be affected by insect infestation and relative humidity.

Non-reducing sugar: At 0 days of harvesting, the non-reducing sugar content was found maximum in Narendralalmati

(1.353 g/100g) followed by Pusa RH 42 (1.313 g/100g) and KPH 466 (1.227 g/100g) and minimum was recorded in traditional rice variety IR 64 (1.001 g/100g). Approximately the same results were observed after 4, 8 and 12 month of storage time interval, Narendralalmati, NDR-97, Sarjoo-52 contained maximum non reducing contents [Fig.8].

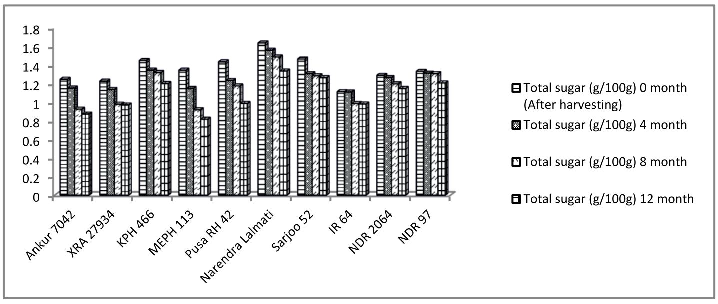

Fig. 6: Changes in total sugar content of hybrid rice and traditional rice varieties under storage intervals

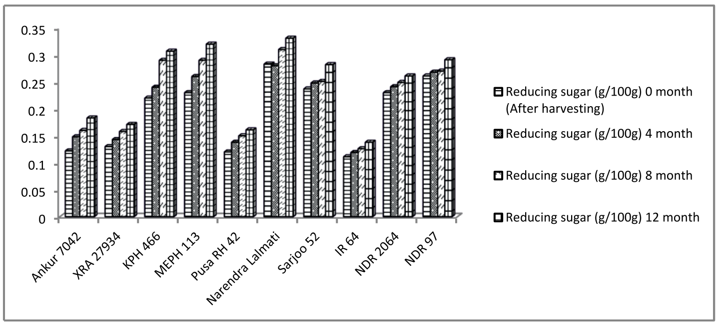

Fig. 7: Changes in reducing sugar content of hybrid rice and traditional rice varieties under storage intervals

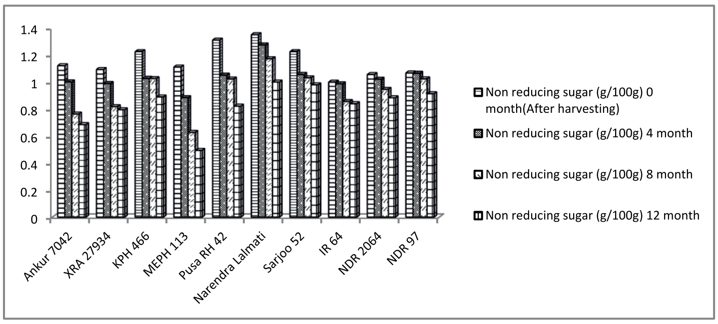

Fig. 8: Changes in non-reducing sugar content of hybrid rice and traditional rice varieties under storage intervals

Under storage study change in non-reducing sugar content was recorded minimum in traditional rice variety NDR 97(14.405 per cent) followed by NDR 2064 (16.272 %) and the maximum was recorded in hybrid rice variety MEPH 113 (55.52%). The results were supported by many previous research findings (7, 21, 22). The decrease in non-reducing sugar content may be due to changes in moisture content, relative humidity, insect infestation, and ageing enzymes as these factors play a major role in the aging of hybrid rice and traditional rice varieties. This study concludes that the comparative study of hybrid rice and traditional rice varieties it can be concluded that traditional rice varieties are better than the hybrid rice varieties. Traditional rice variety NDR 97 is superior because it is a good source of protein, essential amino acids, sugar, and minerals. Traditional rice varieties also have better retention of protein, ash, sugar etc. Hence, NDR 97 has the good keeping qualities which can open new vista for benefiting to farmers and high class of urban society of people and thus have enormous marketing potential in the domestic as well as global scenario.

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Conflict of Intrest: Authors have conflict of intrest.

Future Scope: The health advantages of rice are a major issue for people; thus, further research will focus on rice's nutritional quality, which includes its protein, minerals, fat, and phenolics. Because each nutrient in rice grain is created by a complex pathway involving numerous enzymes or genes, variations may exist among the grains. The incapacity of classical transformation methods to eradicate the endogenous target gene is one of their main drawbacks; customer acceptance is a prerequisite for the success of molecular breeding technologies. Therefore, the use of targeted genome editing techniques along with other contemporary molecular breeding technologies can significantly reduce this obstacle.

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