*Original Research Article*

# EFFECT OF STORAGE CONTAINERS ON NUTRITIONAL QUALITIY OF INDEGENOUS SCENTED RICE (cv. GOBINDABHOG)


.
Abstract :

A storage study was done during 2010-11 and 2011-12 at Rice Laboratory, Department of Agronomy, BCKV, Mohanpur, Nadia, West Bengal, India. The change in mean relative humidity over two years from 71.2 (2-month) to 82.2% (6-month) in the laboratory experiments probably caused a slight increasing trend in moisture content in grain irrespective of storage container used in the study. The variation in material of the containers including their temperature sensitivity, porosity, etc. influenced the moisture content of whole paddy grains at different storage period during both 2011 and 2012. Among containers (*viz.* Gunny bag, Polythene bag, Cloth bag, Earthen pot and Galvanized iron (GI) bin), earthen pot recorded lowest moisture content than other four tested in the experiment. The physical properties of grain (*viz.* kernel length, kernel breadth, L / B ratio, shape, colour, etc.) did not differ significantly among five storage containers during the ageing or storage period. On an average, the protein content in the Gobindabhog rice grain remained largely unchanged during entire 6-month storage time, but amylose content improved slightly upto 4-month, and alkali value and elongation ratio upto 6-month period including non-significant variations among the containers in the experiment. There was a steady decrease in intensity of aroma of Gobindabhog rice during post-harvest storage from 2-month to 6-month period irrespective of container used in the study. The average aroma score over containers after 2-month storage (score 2.53 ± 0.18) declined by 13.83% after 4-month (score 2.18 ± 0.06) and 29.64% after 6-month (score 1.78 ± 0.37). Among storage containers, earthen pot performed best for retention of aroma while jut-made gunny bag appeared unfit for long-term storage of Gobindabhog paddy with respect to grain quality parameters, especially aroma.



*Keywords: Gobindabhog rice, Storage containers, Physical properties, Grain quality, Aroma*


## 1. INTRODUCTION

Rice (*Oryza Sativa* L.) is one of the leading food crops in the world and as well as the staple food for more than a half of the world's population, particularly in Asia [1] and is the primary source of dietary carbohydrates and plays a significant role in nutrient intake [2]. Gobindabhog, short-grain scented rice, is a native cultivar of lower gangetic plains in Bengal, which is traditionally cultivated for about 400–500 years. The agro-morphological characterization of Gobindabhog rice is a traditional non-Basmati type aromatic rice of lower gangetic plains and *rahr* (red and laterite) region of West Bengal [3]. Major quality features of Gobindabhog are: golden-yellow coloured grain, kernel length 3.97 mm, L / B ratio 2.04, short bold type kernel, amylose 17.9%, protein 7.2%, elongation ratio 1.77, alkali spreading value 3.7 and medium-strong aroma [4].

Grain quality is mainly determined by the combination of many physical as well as chemical characters [5]. Rice ageing is a complicated process, which involves changes in physical and chemical properties of rice grain, with variations due to storage methods, time and environment. A proper storage of rough rice is the key factor in maintaining its qualities and the values [6]. Rice during storage undergoes numerous changes in its physical properties and chemical composition, and these changes cause impact on rice cooking and eating quality [7] [8] [9].

High temperature decreases seed set as well as affects grain quality [10] because of reduction in endosperm sink strength and incomplete grain filling [5]. Although the overall starch, protein and lipid contents in rice grain remain essentially unchanged during storage, but structural changes do occur which affect the flavour and texture of cooked rice [11]. On the other hand, low-capacity storage structures have varied influence on grain damage, milling quality, protein content etc. during 10-month storage period [12]. However, no such storage based study on Gobindabhog or such short-grained non-Basmati aromatic rice has not been made till date. Therefore, standardization of storage methods is an important area of present-day research for sustenance of quality including aroma for a longer period.

## 2. MATERIAL AND METHODS

**2.1 Description of Experimental Site:** A storage study was done during 2010-11 and 2011-12 at Rice Laboratory, Department of Agronomy, BCKV, Mohanpur, Nadia, West Bengal, India. Details of the materials used, experimental procedures followed and techniques adopted are described here.

**Table 1: Details of treatments**

| Treatment | Code | Particular |
|---|---|---|
| 5 Storage containers | $C_1$ | Gunny bag (Jute made)<br>[capacity 100 kg, weight 1.02 kg] |
| | $C_2$ | Polythene bag<br>[capacity 50 kg, thickness 130-160 gsm] |
| | $C_3$ | Cloth bag (Markin cloth made)<br>[locally available] |
| | $C_4$ | Earthen pot (Locally made)<br>[locally available] |
| | $C_5$ | Galvinalized iron (GI) bin<br>[sheet thickness 0.50 mm] |

**2.2 Determination of grain quality:** The grain quality parameters were determined during post-harvest period at 'Aromatic Rice Laboratory', BCKV, Mohanpur, Nadia. 100g clean paddy sample of each experimental unit was used to determine the head rice recovery (Rice Mill, Satake make, Japan), and milled rice was used to estimate amylose content [13], alkali spreading value [14], elongation ratio and aroma [15].

$$\text{Head rice (\%)} = \frac{\text{Weight of head rice (g)}}{\text{Weight of rough rice (g)}} \times 100$$

$$\text{ER} = \frac{\text{Length of cooked rice kernel (mm)}}{\text{Length of rice kernel (mm)}}$$

**2.3 Statistical analysis:** The effect of storage containers on quality of Gobindabhog rice during different storage periods was tested in completely randomized design (C.R.D.) with 4 replications at Rice Laboratory, Department of Agronomy, B.C.K.V., Mohanpur, Nadia during 2011 and 2012.

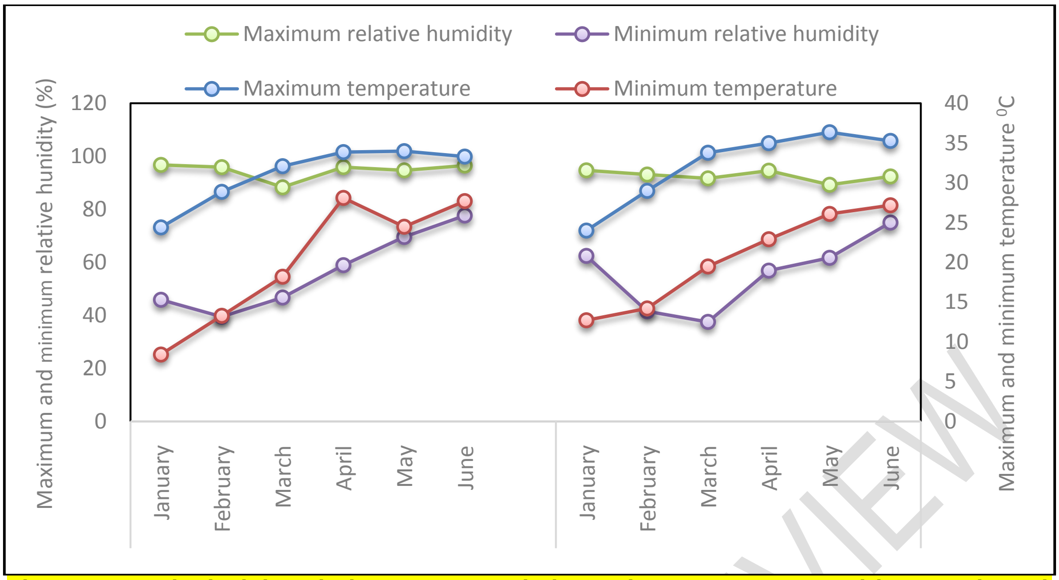



**Fig 1: Meteorological data during storage period at Mohanpur, West Bengal (2011 and 2012)**
[Source: Department of Agricultural Meteorology and Physics, Faculty of Agriculture, BCKV, Mohanpur, W.B., India]

## 3. RESULTS AND DISCUSSION

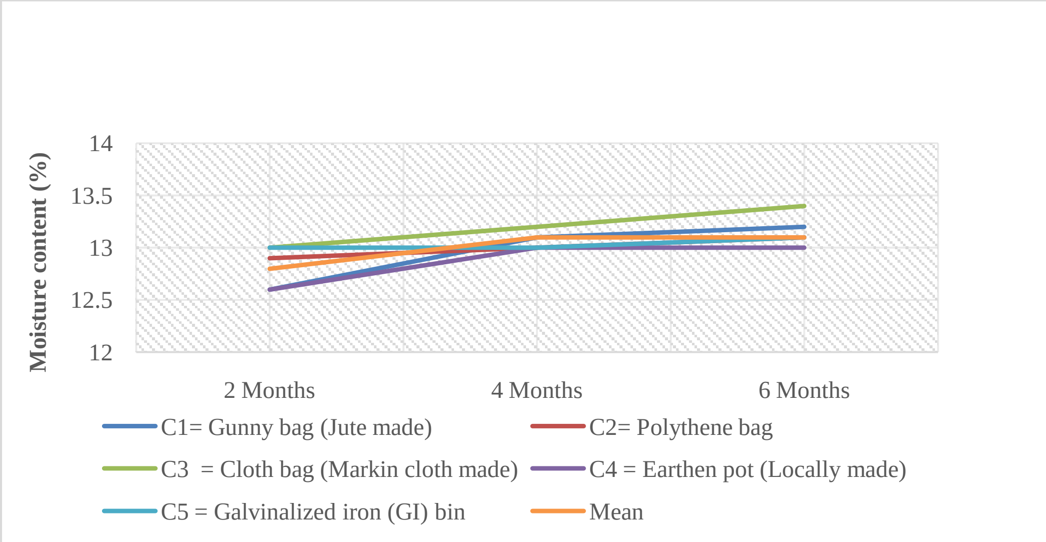
### 3.1 Moisture content

There was a steady increase in maximum, minimum and mean temperature as well as in relative humidity from the start of storage period i.e.0-month to the end of 6-month at the laboratory in the study (Fig.1). This might be due to common seasonal changes in weather from cool and dry (January and February) to hot and humid (May and June) at the experimental site.

The moisture content in paddy or rough rice stored in 5 different containers was significantly influenced after 2-month during 2011 and pooled values; after 4-month time during 2011; and after 6-month during 2012 and pooled values (Fig.2).

The variations in material of the containers including their temperature sensitivity, porosity, etc. influenced the moisture content of whole paddy grains at different storage periods during both 2011 and 2012. It is very important that dried grains be quickly stored in air-tight conditions to prevent moisture adsorption [16]. Furthermore, twelve - fourteen percent was considered to be the optimum paddy moisture content for rice milling [17][18]. Among storage containers earthen pot recorded lowest moisture content than four others used in the study. The grain moisture content in all five containers was usually higher in first year than second year of investigation.

**Fig 2: Effect of storage container on moisture content in grains of Gobindabhog rice during post-harvest storage period**




Perusal of data revealed that there was a slight increasing trend in moisture content from 2-month to 6-month irrespective of the year probably due to change in mean relative humidity over two years values from 71.2 (2-month) to 82.2% (6-month) in the laboratory environment. However, Kanlayakrit and Maweang reported decline in moisture content in two *thai* rice varieties with the advancement of storage period from 0 to 10-month period at Bangkok, Thailand [19].

## 3.2 Grain quality

**Milling quality, Hulling & Head rice recovery**

The effect of the storage methods on milling quality of Gobindabhog rice samples stored as whole grains was evaluated, based on the percentage of brown rice, milled rice and head rice.

After shelling of Gobindabhog paddy, the brown rice content of Gobindabhog varied significantly among five containers after 2-month storage period during 2011 and pooled values, but it remained unaffected after 4-month and 6-month period during both first and second year of investigation. With the advancement of storage period from 60 days to 180 days, the milling recovery showed a decreasing trend irrespective of container and year. The findings could be explained by the fact that the increase in mean relative humidity from 2-month (71.3%) to 6 month (78.8%) period caused slightly greater removal of husk due to softness of paddy.

Mean milling recovery of Gobindabhog rice decreased slightly from 2-month to 6-month period during both 2011 and pooled values. The milled rice content did not vary significantly among storage containers irrespective of storage period and year of investigation.

The head rice recovery of Gobindabhog rice showed definite pattern of change during 2-month to 4-month storage period irrespective of containers between 2011 and 2012, but there was a little decreasing trend in HRR from 4-month to 6-month storage period during both first and second year of post-harvest storage experiment (Fig. 3). The finding is in conformity with [20], but differs wherein a trend of increasing head rice recovery with the ageing of grains for 6-month period was noted probably due to less breakage during milling process [21].

Storage containers had no influence on the head rice recovery of Gobindabhog rice after 2-month period for both 2011 and 2012, but they could affect the HRR after 4-month time during 2012 and pooled values, as well as at the end of 6-month period during 2012 only. The whole grains of Gobindabhog paddy stored in earthen pots usually yielded highest head rice compared to other containers irrespective of storage period and post-harvest year in the study. On the other hand, gunny (jute-made) bag and markin cloth bag recorded lower HRR particularly for longer storage period (120 days and 180 days). This might be due to the increased porosity in two fiber-made bags ($C_1$and $C_3$) caused greater exposure of grains than other three containers. Thus, five storage containers with respect to head rice yield after 6-month period for pooled values could be arranged as: Earthen pot (62.1%) > Polythene bag (61.8%) > Galvanized Iron Bin (61.5%) >Markin cloth bag (61.3%) > Jute Bag (61.1%).

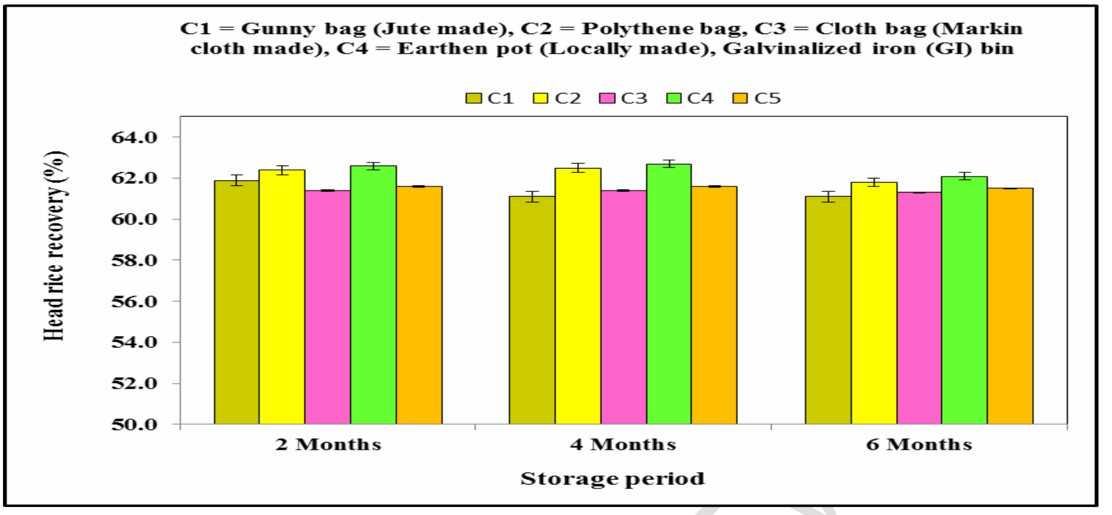



Fig. 3 Effect of storage containers on head rice recovery (%) of Gobindabhog rice during post-harvest storage period

## 3.3 Physical properties of grain

### Kernel length, Kernel breadth & L / B ratio

Kernel length, being a genetical character, was not significantly influenced by 5 different storage containers at 2, 4, 6-month period during both 2011 and 2012 [3]. Storage containers did not have any influence on kernel breadth of Gobindabhog rice at three different periods (60, 120 and 180 days) of storage during both the years of investigation (Table 2).

Like kernel length and breadth of Gobindabhog rice, L / B ratio remained unaffected due to variations in storage containers even at different storage periods during both 2011 and 2012 (Table 2).

**Table 2: Effect of storage container on Kernel length, Kernel breadth and L / B ratio of Gobindabhog rice during post-harvest storage period**

| Storage container | Kernel length (mm) | | | Kernel breadth (mm) | | | L / B ratio | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2 Months | 4 Months | 6 Months | 2 Months | 4 Months | 6 Months | 2 Months | 4 Months | 6 Months |
| $C_1$ | 4.08 | 4.05 | 4.00 | 2.00 | 1.96 | 1.96 | 2.04 | 2.06 | 2.05 |
| $C_2$ | 4.04 | 3.99 | 3.99 | 1.97 | 1.97 | 1.98 | 2.05 | 2.03 | 2.02 |
| $C_3$ | 4.08 | 4.00 | 3.96 | 2.03 | 1.96 | 1.93 | 2.01 | 2.04 | 2.06 |
| $C_4$ | 3.99 | 3.99 | 3.95 | 1.97 | 1.95 | 1.97 | 2.02 | 2.05 | 2.01 |
| $C_5$ | 3.97 | 3.95 | 3.96 | 1.96 | 1.96 | 1.95 | 2.02 | 2.01 | 2.03 |
| Mean | 4.03 | 3.99 | 3.97 | 1.99 | 1.96 | 1.96 | 2.03 | 2.04 | 2.03 |
| S.Em (±) | 0.06 | 0.04 | 0.03 | 0.03 | 0.02 | 0.02 | 0.04 | 0.03 | 0.03 |
| C.D. at 5% | NS | NS | NS | NS | NS | NS | NS | NS | NS |

## 3.4 Cooking quality

### Amylose content, Protein content & Alkali value or Gelatinization temperature

The amylose content in Gobindabhog rice slightly improved with ageing from 2-month to 4-month and declined thereafter toward 6-month period during both 2011 and 2012 (Table 3). Kanlayakrit and Maweag reported non-significant influence or no change in amylose content of two *thai* rice varieties during 10-month storage period at Bangkok, Thailand [19]. While Zheng *et. al,* showed that the effect of high temperature on apparent amylose content and gel consistency in milled rice was cultivar dependent [22]. Based on pooled values, five storage containers with regard to amylose content could be arranged as: Earthen pot (18.15%) ≥ Jute bag (18.03%) ≥ Polythene bag (17.79%) ≥ G.I. bin (17.77%) ≥ Markin cloth bag (17.70%).

The protein content in Gobindabhog rice stored in five different types of containers remained largely unchanged during storage from 2 to 6-month period, excluding after 4-month for pooled values only (Table 3). The finding is consistent with [19] and [23], but differs with [12] wherein little increase in protein content (8.5 - 8.8%) was noted during storage over initial sample (8.4%) in the study at Cuttack, Odisha, India.

Mean containers pooled alkali *(The addition of alkali promoted the degree of gluten polymerization)* value was 3.83 (2-month), 3.98 (4-month) and 4.08 (6-month), which indicated gradual increase in alkali spreading value from short-term to long-term storage in the study (Table 3). The containers did not vary among themselves for alkali value throughout the post-harvest storage period in 2011 and 2012 excluding at 4-month for pooled values only. Above all, the milled rice of Gobindabhog obtained from all samples had intermediate gelatinization temperature.

**Table 3: Effect of storage container on amylose content, protein content and alkali value (score) of Gobindabhog rice during post-harvest storage period**

| Storage container | Amylose content (%) | | | Protein content (%) | | | Alkali value (score) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2 Months | 4 Months | 6 Months | 2 Months | 4 Months | 6 Months | 2 Months | 4 Months | 6 Months |
| $C_1$ | 18.04 | 18.14 | 18.03 | 7.52 | 7.38 | 7.29 | 4.00 | 4.25 | 4.25 |
| $C_2$ | 17.80 | 17.88 | 17.79 | 7.34 | 7.31 | 7.20 | 3.88 | 3.88 | 4.00 |
| $C_3$ | 17.81 | 17.78 | 17.70 | 7.39 | 7.20 | 7.34 | 3.50 | 3.75 | 3.88 |
| $C_4$ | 18.23 | 18.35 | 18.15 | 7.31 | 7.45 | 7.35 | 3.88 | 4.13 | 4.13 |
| $C_5$ | 17.78 | 17.93 | 17.77 | 7.46 | 7.31 | 7.19 | 3.88 | 3.88 | 4.13 |
| **Mean** | 17.93 | 18.02 | 17.89 | 7.41 | 7.33 | 7.27 | 3.83 | 3.98 | 4.08 |
| **S.Em (±)** | 0.11 | 0.10 | 0.10 | 0.25 | 0.05 | 0.14 | 0.19 | 0.14 | 0.17 |
| **C.D. at 5%** | 0.32 | 0.29 | 0.28 | NS | 0.15 | NS | NS | 0.41 | NS |

## 3.5 Processing quality

**Kernel length after cooking, Elongation ratio (ER) & Aroma**

The cooked kernel length of Gobindabhog rice after cooking was unaffected due to variation in storage periods or containers throughout the post-harvest storage period of both 2011 and 2012. Although there was no definite trend of change in cooked kernel length among storage containers during the ageing process in the study, but the grains stored in G.I. bin ($C_5$) showed highest KLAC (7.23 and 7.33 mm) at short-term (2-month) storage, and grains of earthen pot ($C_4$) recorded highest KALC (7.53 and 7.60 mm) at mid-term (4-month) and long-term (6-month) storage in the laboratory.

The results on elongation ratio of Gobindabhog rice stored in five different containers under 2, 4 and 6 month period indicated a slight increase in ER with the lengthening of storage time during both 2011 and 2012. Similar kind of increase in cooked kernel elongation of *thai* paddy varieties during the ageing process was reported by [19]. The whole grains stored in all five containers at room temperature (25 ± $5^0$C) resulted in increase in ER during first 4-month storage, but it continued upto 6-month time for earthen pot only and decreased for markin cloth during 4 to 6-month period.

There was a steady decrease in intensity of aroma of Gobindabhog rice during post-harvest storage from 2-month to 6-month period irrespective of container during both the years of investigation (Fig. 4). The average aroma score over containers after 2-month storage (score 2.53 ± 0.18) declined by 13.83% after 4-month (score 2.18 ± 0.06) and 29.64% after 6-month (score 1.78 ± 0.37). The loss in flavour during the post-harvest storage period was due to release or volatilization of 2-Acetyl-1-pyrroline contain in grain. The finding followed the same trend of decrease in 2-acety-l-pyroline content in *thai* rice (cv. Khao Dawk Mali 105) with increasing storage time from 1 to 10-month period [20].

Among storage containers used in the study, earthen pot ($C_4$) could favorably inhibit the release of 2-acety-l-pyroline from whole grains of Gobindabhog rice compared to other four containers at 2, 4 and 6-month storage period in the investigation; while the loss of aroma in jute bags was very fast between 120 (score 2.13) and 180 days (score 1.38) storage time.

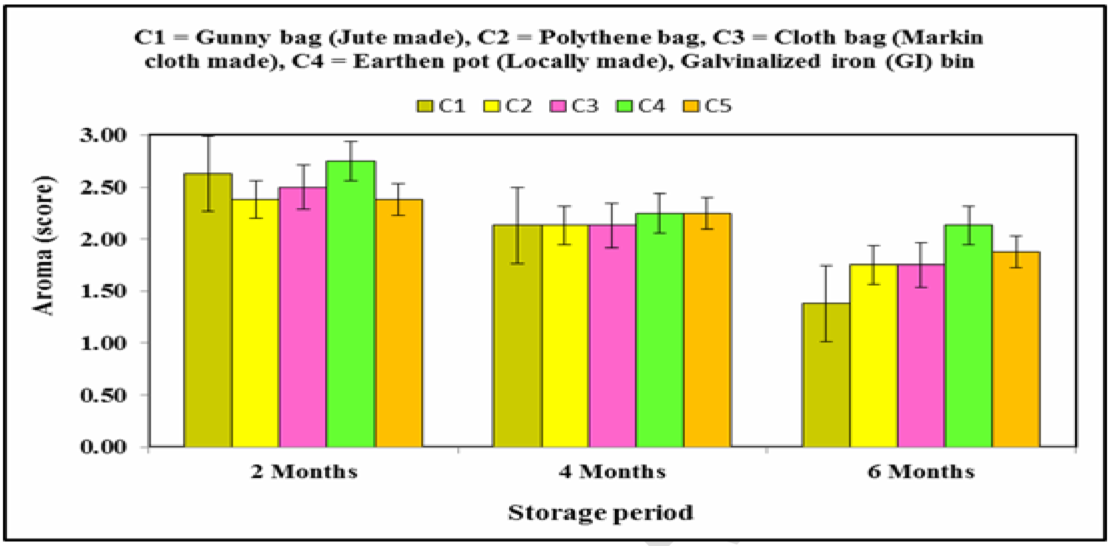


Fig. 4: Effect of storage containers on aroma (score) of Gobindabhog rice during post-harvest storage period

## 4. CONCLUSION

The change in mean relative humidity over two years from 71.2 (2-month) to 82.2% (6-month) in the laboratory experiments probably caused a slight increasing trend in moisture content in grain irrespective of storage container used in the study. The variation in material of the containers including their temperature sensitivity, porosity, etc. influenced the moisture content of whole paddy grains at different storage period during both 2011 and 2012. Among containers, earthen pot recorded lowest moisture content than other four tested in the experiment.

With the advancement of storage time from 60 days to 180 days, the milling quality of Gobindabhog rice (*viz*. hulling, milling and head rice recovery) generally showed slight declining trend, including few significant changes during the post-harvest storage period. Five storage containers, with respect to pooled head rice yield after 6-month storage period could be arranged as: Earthen pot (62.1%) > Polythene bag (61.8%) > Galvanized Iron Bin (61.5%) >Markin cloth bag (61.3%) > Jute Bag (61.1%).

The physical properties of grain (*viz.* kernel length, kernel breadth, L / B ratio, shape, colour, etc.) did not differ significantly among five storage containers during the ageing or storage period. On an average, the protein content in the Gobindabhog rice grain remained largely unchanged during entire 6-month storage time, but amylose content improved slightly upto 4-month, and alkali value and elongation ratio upto 6-month period including non-significant variations among the containers in the experiment.

There was a steady decrease in intensity of aroma of Gobindabhog rice during post-harvest storage from 2-month to 6-month period irrespective of container used in the study. The average aroma score over containers after 2-month storage (score 2.53 ± 0.18) declined by 13.83% after 4-month (score 2.18 ± 0.06) and 29.64% after 6-month (score 1.78 ± 0.37). Among storage containers, earthen pot performed best for retention of aroma while jut-made gunny bag appeared unfit for long-term storage of Gobindabhog paddy with respect to grain quality parameters, especially aroma.

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