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Reema Kshetrimayum and Ngankham Joykumar Singh

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Research Article

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A case study on milling quality of local paddy varieties of Manipur stored in traditional storage methods

Reema Kshetrimayum¹ & Ngankham Joykumar Singh² ✉¹Ph.D Scholar, BCKV, Nadia and²College of Food Technology, Central Agricultural University, Imphal - 795004✉ Corresponding author: NJ Singh, Email: joyngang@gmail.com**Article Info***Article history*

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Key

Traditional grain storage methods; Head rice recovery; Insect damage losses.

Words:**Abstract**

A case study was carried out to introduce improved indigenous storage structures for storing of four local cultivars of paddy. The improved structures were i) polythene lined bamboo storage structure, ii) metal bin, iii) bamboo storage structure plastered with mud and cowdung mix and iv) wooden storage structure. Effect of different storage structures on moisture content, milling recoveries, insect damage, losses due to moisture migration and germination percentage on four local cultivars of paddy, viz; KD, Huikap, Leimaphou and RCM-9 were investigated. Grains at initial moisture content of 12.5% (w.b.) were stored and changes in its quality parameters were observed for 10 months with intervals of one month. The highest changes in grain moisture content were observed in bamboo mat structures plastered with mud-cowdung mix in all paddy cultivars (16.10-16.50%) except in KD (15.20%) after 10 months and the lowest changes were observed in wooden storage structures ranging from 13.75 to 14.22% (w.b.). No significant change in head rice recovery upto four months were observed. However highest head rice yield of 65.91% in KD and lowest 57.00% in Huikap cultivar were observed in wooden structure and bamboo mat structure respectively. Similarly, insect damage on grain was significant only after 4 months and was highest in bamboo mud structure followed by polythene lined bamboo structure. The highest grain loss of 5.0-5.3% was observed in metal bin due to moisture migration in the structure. Germination test of 10 months stored grains did not show significant difference in all cultivars stored in polythene lined bamboo structure, metal bin and wooden storage structure ranging from 90-93% germination. However, bamboo structure plastered with mud-cowdung mix structure gave the poorest germination capacity of 80%.

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Introduction

Rice is a major crop of Eastern India comprising the state of Assam, Manipur, Bihar and West Bengal. Post harvest technology plays an important role in improving the availability of rice in the state. After harvest and threshing of rice, a series of operations such as cleaning, drying, storage and milling are undertaken. It is during these operations, as substantial amount (10-15%) of the grain is lost due to improper handling, thereby affecting the rice availability for consumption and for marketing (Ojha 1978).

Proper cleaning and drying of rice is a prerequisite for its safe storage and milling. Farmers usually harvest the crop at around 18-20% moisture content, which has to be dried up to 12% for safe storage. Sometimes harvesting coincides with rain particularly in Manipur and poses a serious problem of drying and storage of high moisture paddy. Farmers store around 70% of their produce in a traditional way and not aware of the quantum of losses. It is a matter of concern now to bridge the gap between rice productivity and its availability to the farmers for consumption and marketing. This is possible only through loss prevention and value addition by adopting improved techniques of processing and preservation of rice at post production stage (Dash et al.1997). Such an approach further ensures additional income to the farmers, making rice farming profitable and sustainable. The rice obtained from the freshly harvested paddy is less suitable both for processing and culinary utilization whereas adequate aging brings about the desirable properties for the purpose.

Freshly harvested grains of all varieties of paddy exhibit poor milling and cooking characteristics (Peredon et al. 1997). Some of indigenous storage structures are Kot and Kei.

Kot is a temporary storage structure made of bamboo mat standing over a raised bamboo-reinforced platform. The capacity of kot ranges from 1.5 to 5 tonnes. Most of the Kot are circular in shape. The platform is 0.3 to 0.5 m raised above the ground. This structure is kept in the shed. Some people plaster the kot wall with cow-dung. This storage structure can be made with the locally available materials and the cost of construction is low. There is no provision of fumigation. The major storage loss is caused due to rates, mites, birds and moist grains. The storage loss is about 5-9%.

Keis are the large size of paddy storage structure. This is a semi-permanent structure. The floor of the kei is 0.3-0.7m raised from the ground. The structure is either framed by bamboo or wooden pillars. Bamboo strips plastered with mud-straw-cowdung mix is used as wall of the structure. The roof is made of GI sheets or thatched one. The capacity of kei varies from 10 to 25 tones. There is neither rat proof arrangement nor provision of fumigation in this structure is about 5-7%. A study was conducted to study the effect of different traditional and improved storage techniques of some important local varieties of paddy in Manipur.

The aim of present work was to fabricate a suitable storage structure for storage of paddy grains and to study the effect of different storage methods on the quality parameters of stored grains in Manipur climatic conditions.

Materials and Methods

Four improved storage structures were constructed with locally available materials and were used for storage study of four important local paddy varieties of Manipur. i) Polythene lined bamboo storage structure: It was made with bamboo mat. It is a cylindrical in shape and erected over a bamboo reinforced mud platform. The bottom of the structure is also lined with polythene sheet of 700 gauge before loading with paddy. It is kept inside the roofed shed. It has the advantage of fumigation, ii) Metal Bin: Metal bins were made of mild steel sheet of 22 gauge at local workshop. It is cylindrical in shape. It has the capacity of 300 kg of paddy. It has the provision of paddy outlet at bottom. There is provision of fumigation in this bin, iii) Wooden storage structure: The wooden storage structure is made out of wooden planks and square post having the inside dimension of 1.5x1.5x1.5 m. The bottom of the structure is raised by 75 cm from the ground level. Metal inverted cones are provided around the legs of the structure to prevent from climbing rats. The storage capacity of this structure is 1.5 tonnes of paddy. It was kept under a roofed shed and iv) Bamboo mat structure plastered with mud cow-dung mix: cylindrical shaped indigenous structures made of bamboo mat plastered with mud cow-dung mix raised on wooden platform were erected inside roofed shed for the study.

After collection of the freshly harvested four local varieties viz; KD, Huikap, Leimaphou and RCM-9, the foreign material such as dust, dirt, chaff etc were removed using locally made winnower. Paddy loads

were sundried for 2-3 days to bring the moisture content to 12-13% (w.b.) and later on loaded in the different storage structures.

These storage structures were set up at farmer's houses and actual observations were recorded at every one month to check the changes in quality characteristics. Effect of different storage structures on moisture content, milling recoveries, insect damage, losses due to moisture migration and germination percentage for four different paddy varieties were studied.

Changes in moisture content inside the grain mass were recorded by inserting the digital moisture probe at different depths of the storage structure every month starting from Nov, 2015 to September, 2016 kept under natural environmental conditions in farmer's house.

Similarly, milling operation was also carried to find out the milling quality such as head rice recovery, grain damage. A sample size of 200g of different varieties of paddy was taken out from the storage structures for every month. The milling process was carried in two operations, dehushing and polishing. Dehushing was carried out in 'Satake' laboratory sheller (Model THW-35, Japan). The output of the sheller consisted of the brown rice, husk and unhusked paddy which were collected separately in polythene bags. The unshelled paddy and broken in the brown rice were separated manually and weighed using an electronic balance. The samples of brown rice were then milled in a "Satake" rice polisher (Model TM-25, Japan). The milled rice and bran were collected separately and weighed. The broken (less than 3/4th the length of the whole rice) were separated

manually as well as mechanically and then weighed. Later on percentage head rice recovery was calculated. The experiments were repeated for three replications for all the four varieties.

For insect infestation in the stored grain, three samples of 100 g each were taken out randomly from every structure and damaged grain due to insect infestation were visually observed by the concerned entomologist (Khare,1993). Similarly, three samples of 50 g were randomly taken in Petri-disc for germination test. A number of germinated seeds was recorded out of randomly selected 50 paddy seeds and repeated for all the varieties, followed by Agarwal et al. (1987).

Data analysis

Data obtained from the milling studies, changes in moisture content, grain damage, grain loss due to insect infestation and germination test were analyzed using computer software MS-Excel. Three factorial RBD-ANOVA analysis was employed using STPR-15 statistical tool for interactive studies of the different storage structures on the paddy varieties stored at different months.

Result and Discussion

Experiments were conducted on four local paddy varieties of Manipur (KD, Huikap, Leimaphou and RCM-9) at a moisture content $12.5 \pm 0.5\%$ db to study the effect of different storage structures on quality characteristics of paddy grain such as change in moisture content, head rice recovery, grain damage due to insect infestation, grain spoilage due to moisture migration in the structures and germination capacity.

No significant changes were observed in moisture content of all varieties in different storage structures at 5% CD. However highest changes in grain moisture content was observed in bamboo mat structure plastered with mud-cowdung mix in all paddy cultivars (16.10-16.50%) except in KD (15.20%) and lowest changes were observed in wooden storage structure ranging from 13.75 to 14.22% (w.b.) Fig 1. Increasing trend of moisture content was observed in all varieties. First shower rainfall usually occurs in month of April in Manipur. Humidity in the atmosphere during this period starts rising upto 60-70%. The storage structures were found to vary the moisture content depending upon the climatic conditions and rainfall (Shobha, 2006).

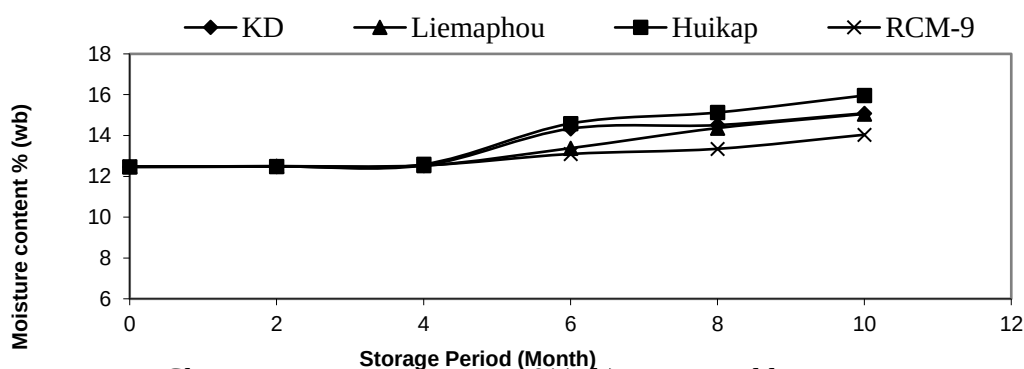


Fig.5 Change in moisture content %(wb) in KD paddy cv. stored in different storage structures

Varietal characteristics and their milling performance

Freshly harvested paddy when subjected to natural aging, milling recovery remains constant while head rice recovery increases. This increase is maximum for KD and RCM-9 followed by Leimaphou variety (Fig 2). Among all varieties under study, Huikap is slenderer. Long slender grains are more

susceptible to breakage affecting the head yield. This is in agreement with Sun and Siebenmorgen et al (1993) and Sahay et al (1980). Highest head rice yield of 65.91% in RCM-9 and KD and lowest 57.00% in Huikap cultivar were observed in wooden structure and bamboo mat structure respectively Table 1.

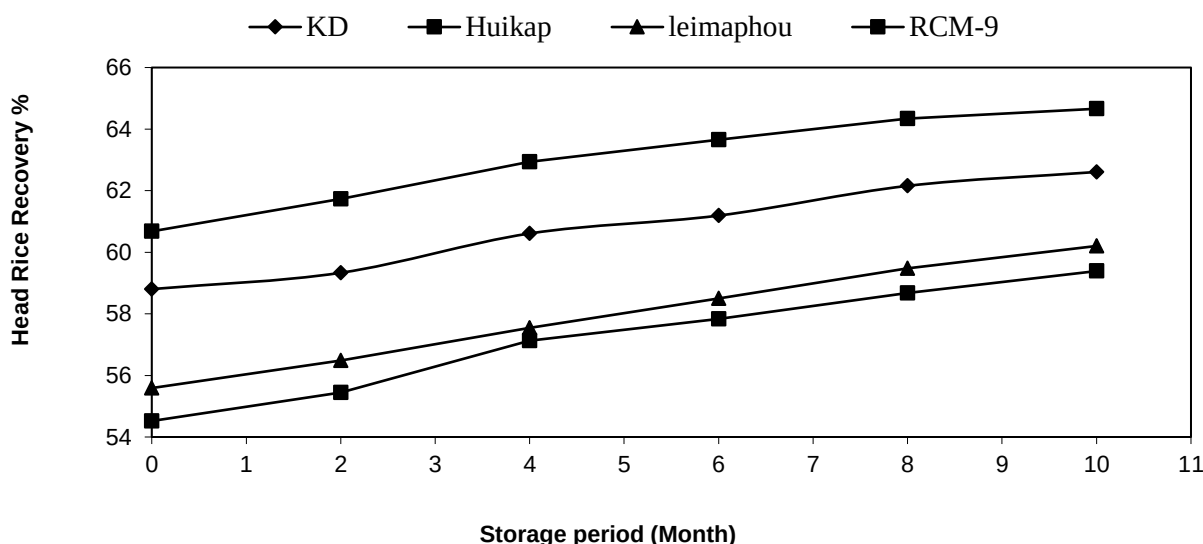


Fig.6 Change in head rice recovery in different Paddy cvs. stored in wooden storage structure

Table 1. Effect of different storage structures on head rice recovery	
Storage Structures	Head rice recovery (%)
Polythene lined bamboo mat structure (S1)	: 61.352
Bamboo mat structure plastered with mud cowdung mix (S2)	: 57.00
Metal bin (S3)	: 60.952
Wooden storage structure (S4)	: 65.91
SEM(±) = 0.04	
CD 5% = 0.09	

Insect damage on grain was significant only after four months and was highest in bamboo mud structure followed by polythene

lined bamboo structure Table 2. The loss due to moisture migration inside the storage structure was also observed for all the storage

methods. As shown in Table 3, metal bin gave the highest percent of losses as to the extent of 5.3% followed by polythene lined bamboo storage structure as 3.5 %. During the month of April onwards (4-5 months of storage) the atmospheric conditions; temperature rises with frequent rain showers which is favourable for

high microbial activity in metal bin. It required one time agitation of paddy grains during the whole storage period. However metal bins have the advantage of rat proof and other rodent attacks.

Table 2. Effect of insect damage with storage period for different storage structures

Variety	Storage structure	Insect damage after storage period, %				
		2 months	4 months	6 months	8 months	10 months
KD	S1	nil	nil	2.2	2.8	4.2
	S2	nil	nil	2.4	3.2	6.2
	S3	nil	nil	2.4	2.6	3.2
	S4	nil	nil	2.0	2.4	3.4
Huikap	S1	nil	nil	1.2	1.8	2.1
	S2	nil	nil	1.5	2.0	2.0
	S3	nil	nil	1.3	1.8	2.0
	S4	nil	nil	1.0	1.2	1.2
Leimaphou	S1	nil	nil	1.2	1.4	2.2
	S2	nil	nil	1.4	1.6	2.9
	S3	nil	nil	1.2	1.4	1.6
	S4	nil	nil	1.0	1.2	1.5
RCM-9	S1	nil	nil	2.2	2.8	3.2
	S2	nil	nil	2.4	2.6	4.8
	S3	nil	nil	2.2	2.2	2.6
	S4	nil	nil	2.0	2.0	2.4

Table 3. Losses occurred due to moisture migration in different storage structure

Storage structure	Loss occurred after 10 months of storage period, %			
	KD	Huikap	Leimaphou	RCM-9
Polythene line bamboo mat structure	3.0	3.5	2.5	1.5
Bamboo mat structure plastered with mud cowdung	2.0	2.0	1.5	1.5
Metal bin	5.2	5.0	5.3	5.0
Wooden storage structure	2.5	2.5	3.0	2.5
SEM(d) ±	1.10	1.12	1.15	1.11
CD 5%	1.22	1.24	1.32	1.23

Table 4. Germination percent with different storage structures.

Storage structure	Germination after 10 months of storage, %			
	KD	Huikap	Leimaphou	RCM-9
Polythene line bamboo mat structure	91	92	90	93
Bamboo mat structure plastered with mud cowdung mix	82	85	82	86
Metal bin	91	90	91	91
Wooden storage structure	92	91	91	91
SEM(d) $\pm$	0.22	0.21	0.22	0.23
CD 5%	0.38	0.47	0.44	0.50

Germination test after tenth month of stored grains did not show significant difference in all cultivars stored in polythene lined bamboo structure, metal bin and wooden storage

structure ranging from 90-93% germination Table 4. However, bamboo structure plastered with mud-cowdung mix structure gave the poorest germination capacity of 80% as there was more insect infestation. RCM-9 was found to have the highest germination capacity. This agrees to finding of Kusuda *et al* (2002) that RCM-9 contained the lowest moisture content of 12.99% after 10 months of storage.

S1=Polythene lined bamboo mat structure, S2= Bamboo mat structure plastered with mud cowdung mix, S3 = Metal bin & S4 = Wooden storage structure

Conclusion

Traditional storage methods based on local resources, at producer level are usually well adapted to all the types of grain and the environment in which they are employed. These eco-friendly and safe storage structures in use since a very long periods have withstood the test of time. The introduction of wooden storage and metal bin structures is

very much accepted by the farmers. It reduces insect damage and moisture losses and increases the safe storage life of grain and head rice recovery. The highest change in grain moisture content was observed in bamboo mat structures plastered with mud-cowdung mix in all paddy cultivars (16.1-16.5%) except in KD (15.2%) after 10 months and lowest change was observed in wooden storage structure ranging from 13.8 to 14.2% (w.b.). The highest head rice yield of 65.9% in KD and lowest of 57.0% in Huikap cultivar were observed in wooden structure and bamboo mat structure, respectively. The insect damage loss on grain was significant only after 4 months and was highest in bamboo mud structure, followed by polythene lined bamboo structure. The highest grain loss of 5.0-5.3% was observed in metal bin structure due to moisture migration. In case of germination test, 10 months stored grains did not show significant difference in all cultivars stored in polythene lined bamboo structure, metal bin and wooden storage structure ranging from 90-93% germination. However, bamboo structure plastered with mud-cowdung mix structure gave the poorest germination capacity (less than 80%). Hence,

the improved indigenous storage methods had effects on the quality of different paddy cultivars under study.

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