Indian Journal of Traditional Knowledge
Vol. 11(3), July 2012, pp. 553-555

Extension of shelf life of brown rice with some traditionally available materials

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Received 19.01.10, revised 09.11.10

Different traditional materials were tested as for their effect on storability of brown rice. After six months of storage at ambient temperature samples stored with *parad* tablet and boric acid remained free flowing and maintained a healthy look during the period while others got infested with ants within 45 days. The sample protected with *parad* tablet had normal appearance and good taste on cooking, bifurcation of cooked grains at both ends and a watery taste were observed in grains protected with boric acid. The amount of free fatty acid (FFA) and malondialdehyde (MDA) increased in control samples during storage, whereas the *parad* tablet protected samples showed little variation. Moreover, storage with *parad* tablet was also found to be effective in preventing the loss of carbohydrate, protein and lipid. The objective of the study was to find a suitable protectant(s) which is locally available and can extend the shelf life of brown rice which is otherwise nutritionally very rich.

Keywords: Brown rice, Storage, *Parad* tablet, FFA, MDA

IPC Int. Cl.[8]: B65G, A01G 9/00, A01G 16/00, A47F 5/00, A47F 7/00, A63B

Rice is the richest in nutrients as brown rice (rice with the husk taken off) because of the nutrient dense bran layer found on the grain surface. Nonetheless, this layer is removed deliberately (along with the husk) during milling as it makes rice prone to infestation by insects and microorganisms leading to spoilage of grains in storage[1]. The hulling process also breaks up cells in the outer layer, releasing lipase enzyme which catalyzes break down of the oil in the bran layer, liberating free fatty acids that cause rancidity and off flavor. Both of these factors are responsible for the short shelf life and poor acceptability of brown rice among the masses. As rice is a staple food for the common people in India and several other Asian countries, it is highly desirable to develop a technique to extend the shelf life of brown rice so that the poor can avail its health benefits. Researchers in the Philippines showed that brown rice could be stored with 14% moisture for 90-150 days at 23-35°C without vacuum drying[2]; samples with higher moisture content could be stored in sealed polyethylene bags (2-5 kg) for 2-3 weeks or even longer in a refrigerator[2]. The present study deals with the effectiveness of some common materials on the shelf life of brown rice stored at room temperature.

Methodology

The experiments were conducted in the Biochemistry Laboratory of Central Rice Research Institute, Cuttack, Orissa. All the cultivars were grown with standard package of agronomic practices (N:P:K ratio of 80:40:40) during the *Kharif* season of 2008. Grains were sun dried to a moisture content of 12-14% and then left to season for 3 months before they were used in the experiment. Parboiling was done in a mini parboiling unit (250gm capacity). Grains were sun dried and dehulled in a Satake Huller (Model THU, Class 35A). Brown rice samples, both parboiled and non-parboiled, of 10 popular rice varieties, viz. *Gayatri*, *Pooja*, *Durga*, *Vandana*, *Naveen*, *Tapaswini*, *Heera*, *Udaya*, *Ratna* and *Samalei* were stored in paper bags at room temperature and analyzed for free fatty acid (FFA) content. Free fatty acids were estimated by titrating grain lipid with 0.1 N KOH using phenolphthalein indicator after 30 days[3]. Total lipid was estimated by conventional Soxhlet method using petroleum ether as extraction solvent. Malondialdehyde (MDA) content was determined by thiobarbituric method[4]. Crude

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protein (Nx5.95) content was estimated by micro-Kjeldahl method[5]. Total carbohydrate content was determined by anthrone method[6].

In another experiment, parboiled brown rice grains (1kg) of the popular variety *Gayatri* were mixed well with 1gm dry powder of each of the locally available protectants [viz. dry neem (*Azadiracta indica*) leaves, *Vitex negundo* leaves, turmeric (*Curcuma longa*) powder, and boric acid] and stored at room temperature (27-37°C) in screw capped glass containers (1 kg capacity). One *parad* tablet was wrapped in a muslin cloth and placed on the rice sample in one of such containers. This tablet, a traditional *Ayurvedic* formulation made by Zandu Pharmacy (India), is used for deworming, but has been in use for long by the people for safe storage of whole grain pulses.

All the experiments were conducted in completely randomized design.

Results and discussion

Parboiling was found to reduce FFA development by up to 34.86% depending upon the variety, compared to the non-parboiled brown rice (Fig. 1). Some varieties such as *Tapaswini*, *Samalei*, *Uday* and *Pooja* showed higher production of FFA in non-parboliled rice samples (22.49 to 37.50%) than the remaining varieties (Fig. 1). This difference among the cultivars might be genetic and might be linked to the lipid content of the grain. Lowering of FFA content in parboiled samples was, perhaps, due to stabilization of rice bran by inactivation of the lipase[7].

Brown rice grains stored with different locally available protectants were monitored for insect and mould infestation, off flavours and taste at 30 days interval for 6 months. Clump formation was observed in control samples within 60 days with gradual change in grain color to deep brown or even black. Samples protected with *parad* tablet and boric acid remained free flowing and maintained a healthy look during the period while others got infested with ants within 45 days (which could be seen from outside). Whereas the sample protected with *parad* tablet had normal appearance and good taste on cooking, bifurcation of cooked grains at both ends and a watery taste was observed in grains protected with boric acid, which was most evident in 6 months old samples.

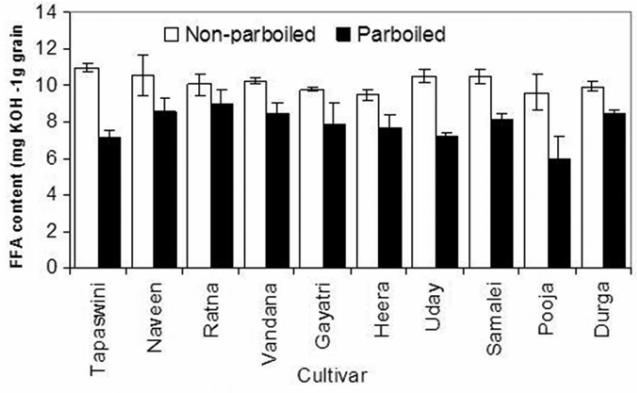

Fig. 1—Free fatty acid (FFA) levels in the parboiled and non-parboiled brown rice samples of different cultivars of rice. Results presented are mean ± sd of 3 replicates.

Malondialdehyde (MDA) and FFA content of stored food are considered to be biochemical indicators of spoilage[8]. Thus, their amount was also determined in stored grains (at an interval of 30 days for 6 months) to find if the presence *parad* tablet could check the development of these compounds. The amount of FFA and MDA increased gradually in control samples (18.37 and 29.6% increase, respectively after 6 months) during the storage. Malondialdehyde (MDA) and FFA content of *parad* tablet protected samples showed gradual decrease with time (Fig. 2).

Among the three major nutrients, viz. total crude protein, carbohydrates and lipid, total lipid content was found to be highly affected (29.84% as compared to the initial level) in storage followed by total carbohydrates and crude protein. Crude protein and total carbohydrate contents were found to be almost equally affected in the control grains (4.15 and 5.83% reduction respectively, as compared to initial level).

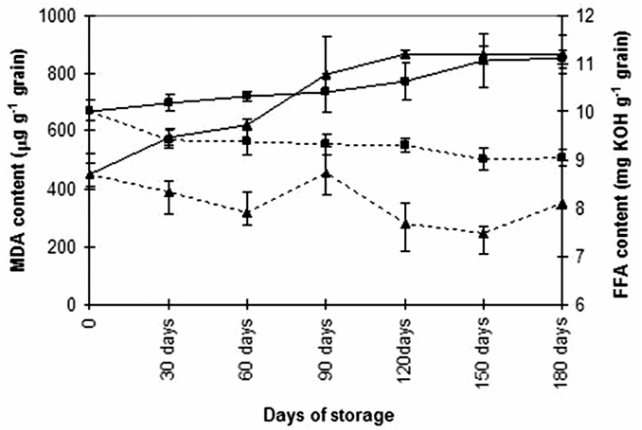

Fig. 2—Free fatty acid (FFA) and malondialdehyde (MDA) levels in the parboiled brown rice samples of the variety *Gayatri* after different days of storage with (⋯⋯) and without (——) *parad* tablet. (Lines with boxes represent MDA content and those with triangles indicate FFA content). Results presented are mean ± sd of 3 replicates.

Table 1—Nutrient composition (%, w/w) of parboiled brown rice samples of the cultivar *Gayatri* (with and without *parad* tablet) after 6 months of storage

Constituent	Initial	After 6 months of storage	
		Control	*Parad* tablet
Total crude protein	9.40 ± 0.25	9.01 ± 0.39	9.33 ± 0.65
Total carbohydrate	75.50 ± 3.3	71.10 ± 5.5	75.44 ± 1.80
Total lipids	3.15± 0.21	2.21 ± 0.15	3.11 ± 0.17

*Results presented are mean ± sd of 3 replicates

However, storage with *parad* tablet was found to be effective in preventing the loss of all the three nutrients (Table 1). Effect of *parad* tablet in preventing nutrient losses might also be due to its antimicrobial effect.

Thus, the results indicate that parboiling of paddy followed by storing the brown rice grains with *parad* tablet can help extend the shelf life for more than six months. The *parad* tablet, which costs less than one rupee a tablet, was found to be the best in maintaining a healthy look and taste of grains. Although the exact mechanism of action is not known, the effect of *parad* tablet on prolonging the shelf life might be due to suppression of development of FFA and MDA. Hence, it can be used quite effectively to extend the shelf life of brown rice for at least six months. In fact, when the *parad* tablet protected samples were examined after one year, no off flavor or change in appearance or taste of cooked grains was noted. There was virtually no change in weight of tablet. Perhaps, the tablet retains its activity for a long time, since it is used repeatedly by people to protect pulse grains.

Conclusion

Parboiling of brown rice followed by storing with *parad tablet*, a commercial formulation from Zandu Pharmacy, was found effective in extending the shelf life of brown rice (more than six months). This was possible due to reduction in the development of rancidity (as evidenced by lower FFA and MDA content of the *parad tablet*-protected samples). As compared to the control grains, amounts of all the three major nutrients viz. carbohydrate, protein and fat remained were found to remain unaffected during storage with *parad tablet*. It was concluded that brown rice, which is easily damaged in storage due to nutrient rich outer layer, can have a longer shelf life if parboiled and stored with *parad tablet*.

Brown rice is nutritionally very rich but due to poor shelf life its nutritional power is not fully realized. Farmers can overcome this problem by storing parboiled brown rice with *parad tablet* which is commercially available in the market.

Acknowledgement

The authors wish to thank the Director, Central Rice Research Institute, Orissa, India for providing necessary facilities to carry out the work.

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