Asian-Aust. J. Anim. Sci.
Vol. 21, No. 3 : 420 - 425
March 2008

www.ajas.info

Effect of Storage Time on the Rancidity and Metabolizable Energy of Rice Polishing in Poultry

T. N. Pasha*, F. M. Khattak[1], D. R. Khan and M. A. Jabbar
Department of Animal Nutrition, Faculty of Animal Production and Technology
University of Veterinary and Animal Sciences, Lahore, 54000 Pakistan

ABSTRACT : The storage of rice polishing (RP) with and without addition of antioxidant for sixteen weeks and its effect on rancidity and metabolizable energy values during the summer season was determined. Fifteen Single Comb White Leghorn cockerels of approximately uniform age and weight were procured and kept in metabolic cages under standard feeding and management practices. Five force feeding trials were conducted. In the first trial, fresh RP with 0 weeks of storage (diet 1 and 2) was used followed by four feeding trials with 4 (diet 3, 4), 8 (diet 5, 6), 12 (diet 7, 8), and 16 (diet 9, 10) weeks of storage of RP. The same birds were used in all trails. The birds were fasted for a period of 21 h, followed by force feeding of 20 g of RP with and without antioxidant for all storage periods. The control/fasting group was also maintained to measure endogenous fecal losses. Excreta were collected after 48 h for the determination of AME and TME values of RP. Along with the biological trials, laboratory assay of the RP stored with and without antioxidant was conducted to measure the extent of rancidity in terms of Thiobarbituric acid value (TBA). The TBA values were affected ($p<0.05$) by storage period and the values increased when the storage period increased from 4 to 16 weeks. However, the TBA values were significantly reduced ($p<0.05$) when RP was stored after addition of antioxidant when compared with the values obtained from RP stored without antioxidant (diet 3 vs. 4, 5 vs. 6, 7 vs. 8, and 9 vs. 10). The AME MJ/kg and TME MJ/kg values of RP were neither affected by increase in storage period nor addition of antioxidant. The findings of this study revealed that there was no effect of rancidity and storage time on the nutritive value, AME or TME of RP in poultry. However, TBA values were increased with the increase in storage period. (**Key Words :** Storage Time, Rancidity, Metabolizable Energy, Rice Polishing, Poultry)

INTRODUCTION

Poultry competes with human beings in utilization of available cereals, because the bulk of their diet in Pakistan comprises cereal grains like maize, wheat, sorghum and rice, which with the passage of time are becoming expensive. Now there is a great need to explore new feed resources for replacing the costly ones. For example, we can substitute wheat which is a major cereal for human consumption, with Rice Polishing (RP) which is not consumed by human beings. It is reported that RP provide almost equivalent nutrients/energy for poultry (Jadhao et al., 1999) when compared with wheat and thus will help to conserve cereals for human use. There is also a stressing demand to exploit potential resources of feed, provide better storage facilities and save the feed ingredients from unwanted biochemical processes like oxidative, hydrolytic and ketonic rancidity of fat in the feed/feed stuffs.

RP is an economical source of energy and protein for animal feed in South East Asia and is currently being used as a poultry feed ingredient. Its inclusion in poultry rations helps in preparing economical and efficient rations and to spare huge quantities of cereal grains. RP is abundantly available in Pakistan because rice is the third largest crop produced there. Rice production in the year 2005-2006 was 5,547 thousand tons (Economic Survey of Pakistan 2005-2006).

RP is a primary by-product of the rice milling industry. It is derived from the outer layer of Caryopses during milling and includes pericap, seed coat, aleurone layer, germ and part of the subcutaneous layer of starchy

* Corresponding Author: T. N. Pasha. Tel: +92-42-9213528, Fax: +92-42-9211461, E-mail: agrotech@brain.net.pk
[1] Department of Poultry Production, Faculty of Animal Production and Technology, University of Veterinary and Animal Sciences, Lahore, 54000 Pakistan.
Received June 18, 2007; Accepted October 10, 2007

Table 1. Average temperature and humidity chart of storage room on weekly basis from May through September 2005 in Lahore-Pakistan

Weeks of storage	Temperature range (Min to Max °C)	Humidity range (Min to Max %)
1	26.5-30	20-30
2	28-31	21-29
3	30-32	18-23
4	35-39	22-42
5	28-39	31-48
6	35-41	27-50
7	27-40	66-93
8	27-32	75-80
9	28-35	78-90
10	27-33	73-86
11	27.5-32	68-72
12	28-31	65-71
13	27.5-30	63-69
14	27-30	50-55
15	26.5-28.5	38-40
16	26.5-27.4	30-35

endosperm. It is an excellent feed ingredient for cattle, buffalo, sheep, swine and poultry (Banerjee, 1999; Chae et al., 2002; Chae and Lee, 2002). It furnishes comparable energy to other cereals and, at the same time, is a good source of protein and water soluble vitamins, especially thiamin, niacin, but has comparatively higher fiber content than other cereals (Seiden and Pfander, 1957).

The feed industry in Pakistan is facing a serious problem of rancidity in RP due to high percentages of fat and lipolytic enzymes particularly when stored RP is used in the feed. Due to high lipid content, RP contains the necessary substrate for development of rancidity. Hydrolysis of the glycerides of the oil in RP to form free fatty acids in the untreated form is the principal cause of deterioration occurring rapidly during the first few days or weeks after milling (Randall et al., 1985; Ramezanzadeh et al., 1999a; Lone et al., 2003; Khalique et al., 2006).

It is important to know the energy values of locally available RP prior to ration formulation. The most widely used energy system for poultry is Apparent Metabolizable Energy (AME) and True Metabolizable Energy (TME). The Metabolizable Energy of typical broiler feed formulated based on book value could easily vary by 2 MJ/kg or more. Therefore, it is important to know accurate values as these variations are very costly and they reduce the level of live performance and carcass quality and ultimately reduce profitability (Miller and Reinecke, 1984).

The present study was undertaken to chemically analyze locally available RP stored for different intervals in the hot summer months, then to determine rancidity of RP in terms of TBA number and also determine AME and TME values of the birds fed on RP with and without antioxidant for different periods of time.

MATERIALS AND METHODS

Experimental birds

Fifteen Single Comb White Leghorn cockerels of 20 wks age and 1,300±20 g BW were divided into three groups i.e. 1, 2 and 3, and were randomly housed in individual cages, with dimensions of 30.5×30.5×30.5 cm, each having water and feeders. The shed temperature was maintained around 30°C and was fumigated with formaldehyde gas before the placement of birds. However, the humidity varied from 20 to 90% during this period. The experiment was conducted in the hot summer months (May till September) in the experimental unit of the University of Veterinary and Animal Sciences, Lahore, Pakistan. After shifting to the cages, the experimental birds were provided an adjustment period of 3 days.

Collection and processing of rice polishing

The RP (with 10-11% oil) was collected from a local rice mill in such a way that it was processed within 6 h of milling. Prior to storage the RP was divided into two groups i.e. 1 and 2. In group 1 the RP was mixed with antioxidant (Oxistat®, which contained *Butylated Hydroxytoluene*, *Butylated Hydroxyanisole*, *Ethoxiquine*, *Sodium Citrate*, *Calcium Carbonate*) in a horizontal ribbon mixer at a dose rate of 250 g/ton, and in group 2 fresh RP was kept without antioxidant. After mixing, RP was packed in jute bags and stored at room temperature for 0, 4, 8, 12 and 16 wks and RP was analyzed for proximate composition (Table 2) and TBA values (Table 3) at the end of each storage period. Temperature and humidity of the storage room was recorded daily throughout the storage time of 16 weeks (Table 1).

Force feeding procedure

The force feeding technique described by Sibbald, (1976) was used five times at 0 (treated as fresh), 4, 8, 12 and 16 weeks of storage. The birds were kept on 21h fasting to empty the alimentary canal and then 20 gms of RP was force-fed into the crop of each bird with a funnel of 1.3 cm internal and 1.5 cm external diameter. A plunger was used to push the feed into the crop of bird. At the same time representative samples of RP from each group were kept in airtight containers for chemical analysis. Birds in group 1 were force fed with RP containing antioxidant (diet 1, 3, 5, 7 and 9) and birds of group 2 with RP without antioxidant

Table 2. Proximate composition (DM basis) of rice polishing stored for different periods

Treatment	Storage period (Weeks)	Anti-oxidant	CP±SE (%)	EE±SE (%)	CF±SE (%)	NFE±SE (%)	Ash±SE (%)	Moisture (%)
1	0	Yes	10.55±0.07	12.03±0.06	15.16±0.19	47.46±0.20	8.17±0.21	6.62±0.62
2	0	No	10.15±0.07	12.01±0.04	15.30±0.14	47.46±0.20	8.60±0.14	6.47±0.08
3	4	Yes	10.50±0.14	11.89±0.22	15.50±0.14	48.46±0.19	8.36±0.19	5.28±0.51
4	4	No	10.40±0.14	11.97±0.11	15.14±0.36	47.85±0.24	8.15±0.49	6.49±0.84
5	8	Yes	10.55±0.14	12.20±0.13	15.15±0.23	48.17±1.15	7.80±0.01	6.11±1.39
6	8	No	10.65±0.21	12.20±0.13	15.13±0.38	47.30±1.01	8.15±0.49	6.56±5.47
7	12	Yes	10.59±0.01	12.03±0.07	15.06±0.02	48.48±0.70	8.36±0.19	5.47±0.48
8	12	No	10.60±0.14	11.98±0.14	15.29±0.43	48.48±0.70	8.36±0.19	5.28±0.08
9	16	Yes	10.64±0.23	11.97±0.11	14.88±0.19	48.18±0.23	8.31±0.26	6.01±0.10
10	16	No	10.57±0.09	11.81±0.44	14.89±0.13	48.00±0.02	8.32±0.24	6.40±0.06
Sig			NS	NS	NS	NS	NS	NS

There is no difference in means at p>0.05. CP = Crude protein, EE = Ether extract, CF = Crude fiber and NFE = Nitrogen free extract.

(diet 2, 4, 6, 8 and 10) at 0 (treated as fresh), 4, 8, 12 and 16 weeks of storage and group 3 (Control) remained on fasting for the determination of endogenous losses. Each bird was removed from the cage, fed the RP and placed back into same cage. Water was provided *ad libitum*. The same feeding technique was used in all five force feeding trials. In the first trial, fresh RP with 0 weeks of storage (diet 1 and 2) was used followed by four feeding trials with 4 (diet 3, 4), 8 (diet 5, 6), 12 (diet 7, 8), and 16 (diet 9, 10) weeks of storage of RP.

Excreta collection

In all five trials excreta were collected over a period of 48 h (Sibbald, 1976; Chami et al., 1980) in individual tray covered with plastic sheet and placed at the bottom of each cage. Droppings on the wire mesh of the cage were also collected. The trays were detached, and feathers were removed from the droppings to avoid contamination. Excreta were oven dried at 60°C, weighed, homogenized and ground for the estimation of gross energy by adiabatic bomb calorimeter (IKA® C2000 WERKE).

Calculation of metabolizable energy

Gross energy of test samples and collected excreta was determined on a DM basis at 0, 4, 8, 12 and 16 wk of storage periods of RP and AME and TME values were calculated by the following formulae used by Chami et al. (1980).

$$AME\ (kcal/kg) = IE-(FE+UE)/weight\ of\ sample\times 1{,}000$$

$$TME\ (kcal/kg) = IE-(FE+UE)+(FmE+UeE)\ /weight\ of\ sample\times 1{,}000$$

Where, IE = Gross energy ingested, FE = Fecal energy, UE = Urinary energy, FmE = Metabolic fecal energy and UeE = Endogenous urinary energy.

Determination of thiobarbituric acid values by modified extraction method

The absorption spectrum generated by adding the TBA reagent to the distillates or filtrate containing malendyaldehyde (MDA) was identical to that of the complex formed between TBA and 1,1,3,3-tetraethoxypropane, thus the TBA reaction was considered to be a valid indicator of MDA in feedstuffs (Salih et al., 1987; Hamilton and Kristein, 2003).

Statistical analysis

The data on proximate analysis, TBA values and TME and AME were tabulated and subjected to statistical analysis using an analysis of variance technique according to a completely randomized design using the general linear models of Minitab® software. Duncan's Multiple Range Test and T-test were applied to compare the means.

RESULTS AND DISCUSSION

Proximate composition

Proximate composition of RP was not affected (p>0.05) throughout the storage period from 0-16 wks in both groups (Table 2). The values for crude protein (CP), ether extract (EE), crude fiber (CF) and crude ash and nitrogen free extract (NFE) observed in this study were lower compared with data reported by Mahatab (1985), Sarkar and Bhattacharyya (1989) and Warren and Farrel (1990). These variations in values are supported by the work of Loosli et al. (1954) who reported that chemical composition of RP varies widely due to different agro-ecological regions and processing methods; some processes allow for more addition of rice hulls than others.

Table 3. Thiobarbituric acid value (TBA values), apparent metabolisable energy (AME) and true metabloisable energy (TME) values of rice polishing

Treatment	Storage period (weeks)	Antioxidant	TBA±SE (mg MDA/kg)	AME±SE (MJ/kg)	TME±SE (MJ/kg)
1	0	Yes	0.036^{a}±0.001	8.17^{a}±0.25	10.11^{a}±0.24
2	0	No	0.037^{a}±0.001	8.20^{a}±0.82	10.12^{a}±0.84
3	4	Yes	0.036^{a}±0.001	8.18^{a}±0.08	10.25^{a}±0.09
4	4	No	0.057^{b}±0.001	8.20^{a}±0.07	10.30^{a}±0.07
5	8	Yes	0.081^{c}±0.001	8.22^{a}±0.15	10.41^{a} ±0.16
6	8	No	0.174^{d}±0.002	8.24^{a}±0.07	10.44^{a}±0.06
7	12	Yes	0.094^{e}±0.001	8.32^{a}±0.71	10.57^{a}±0.71
8	12	No	0.196^{f}±0.002	8.47^{a}±1.04	10.61^{a}±1.10
9	16	Yes	0.186^{f}±0.003	8.39^{a}±0.15	10.71^{b}±0.17
10	16	No	0.234^{g}±0.003	8.56^{a}±0.12	10.75^{b}±0.13
Significance			*	NS	NS
Storage			*	NS	*
Antioxidant			*	NS	NS

Mean±standard error with different superscripts in the same column differ ($p<0.05$).

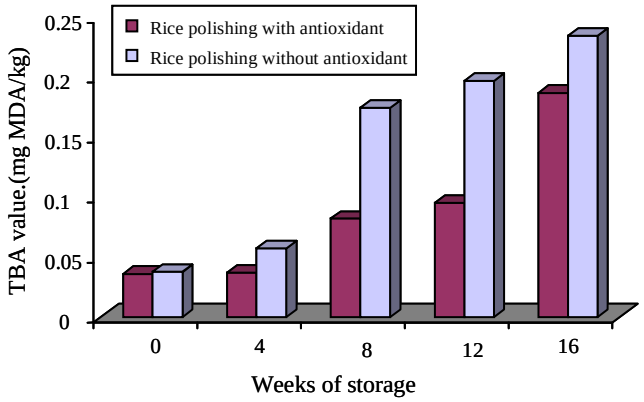

Figure 1. Thiobarbituric acid values of rice polishing after different periods of storage (0-16 weeks).

The data presented in Table 2 revealed that the chemical composition of RP used in this study was not influenced by the addition of antioxidant as well as different storage intervals from 0 through 16 weeks. These findings are in agreement with the studies of Ramezanzadeh et al. (2000), Chrastil (1990), Malekian et al. (2000), Wadsworth and Koltun (1986) and Yeo and Shibamoto (1991) who reported non-significant effects of antioxidant and storage periods on the chemical composition of RP.

Thiobarbituric acid value (TBA value)

TBA value of the RP was affected by both factors i.e storage period as well as addition of antioxidant (Table 3). A gradual and significant ($p<0.05$) change was observed in the TBA value of RP between both the groups i.e. 1 and 2 and all the storage intervals from 0-16 wks. The values ranged from 0.036-0.186 mg of MDA/kg for group 1 and 0.0367-0.234 mg of MDA/kg for group 2. Krik and Sawyer (1991) reported that refined rice bran stored in good condition has TBA values of 0.02-0.08, whereas crude oil or badly stored oils have values of 0.1-0.2. Thus, in the present study it can be assumed that RP stored with antioxidant can be considered in good condition up to week 12 as TBA value varied from 0.036 to 0.094 in this period; this compared to diets without antioxidant which after 8 weeks indicated bad storage conditions as the values varied from 0.174 to 0.234 (wk 8 to wk 16).

The TBA values of RP significantly increased with the increase in storage period irrespective of whether it was with or without antioxidant. However, it is evident that addition of antioxidant in RP drastically reduced the TBA values. This trend is supported by the findings of Hussein and Kratzer (1982), who reported that the free fatty acid content of rice bran fat before storage was 13.7% and increased to 42.8% during a 3-month storage period. They further reported that by the addition of EDTA, free fatty acid content was maintained at 16.1% at the end of the storage period. Thus results from this experiment indicated that addition of antioxidant at 250 g/ton delayed the rancidity process.

Metabolizable energy

AME and TME values of RP of both the groups were determined after different storage periods (Table 3). AME did not change significantly between fresh and rancid RP and it varied from 8.17 MJ/kg to 8.39 MJ/kg for group 1 birds fed on diets containing antioxidant and from 8.20 to 8.56 MJ/kg for birds of group 2 fed on diets without antioxidant over the 16 wks storage period. These findings are supported by the work of Hussien and Kratzer (1982) who stored rice bran for a period of three months under room temperature and concluded that rancidity had no

effect on the energy content of the rice bran. They also reported that there was no significant difference between the metabolizable energy and AME values of the diets containing fresh rice bran plus EDTA, rancid rice bran and rancid rice bran plus EDTA.

The non-significant effect of rancidity on the energy content of RP is further supported by Scott et al. (1976) and Leeson and Summer (2001) who stated that hydrolytic rancidity does not interfere with the nutritional value of the rice bran and the fat that has undergone hydrolytic rancidity does not influence its nutritional profile. However, it was interesting to note that TME values in this study consistently increased with the increase in storage period from week 1 to week 16, but a significant difference ($p<0.05$) was only observed in the last week of storage (16 weeks), whereas the values were 10.71 and 10.75 for diet 9 and 10 when compared to values of all other storage periods (Table 3). The mean value for the TME of group 1 varied from 10.11 to 10.71 MJ/kg and in group 2 it varied from 10.12 to 10.75 MJ/kg. The interesting point to note in the present study is that addition of an antioxidant had a significant ($p<0.05$) effect on TBA values, and the values increased with increase in storage period. Whereas TME and AME values consistently increased with the increase in storage period, the difference was only significant ($p<0.05$) when the RP was stored for 16 weeks. However, when the data was analysed to study the effect of antioxidant on the TME values, a non-significant ($p>0.05$) effect was observed (Table 3).

The values obtained for TME in this study were lower than in the studies of Chami et al. (1980), who reported the TME of rice bran as 13.6 MJ/kg, and Hussein and Kratzer (1982), who observed a TME value of rancid rice bran of 13.9 MJ/kg which was higher than the TME values of this study. The lower TME values recorded in this study could be due to difference in varieties of rice and its processing techniques.

CONCLUSION

This study revealed that the thiobarbituric acid value increased with the increase in storage period of RP, but there was no significant effect of rancidity on the AME values of RP with the passage of storage time. However, the difference in TME values only became significant ($p<0.05$) when the RP was stored for 16 weeks. Addition of antioxidant showed a consistent trend in decreasing the rancidity of RP and prolonged the freshness of RP, but had no significant affect on energy values. It is therefore recommended that RP, being an economical and nutritious ingredient of poultry feed, must be obtained fresh from the rice mill and must be treated with antioxidant to reduce the rancidity.

REFERENCE

AOAC. 1994. Official Methods of Analysis, Association of Official Analytical Chemists, Washington, DC, USA.

Banerjee, G. C. 1999. A text Book of Animal Husbandry. 8th Edition, Oxford and IBH Publishing Co. PVT. Ltd. New Delhi India. p. 391.

Chami, D. B., P. Vohra and F. H. Kratzer. 1980. Evaluation of a method for determination of true metabolizable energy of feed ingredients. Poult. Sci. 59:569-571.

Chae, B. J. and S. K. Lee. 2002. Rancid rice bran affects growth performance and pork quality in finishing pigs. Asian-Aust. J. Anim. Sci. 15(1):94-101.

Chae, B. J., K. H. Lee and S. K. Lee. 2002. Effects of feeding rancid rice bran on growth performance and chicken meat quality in broiler chicks. Asian-Aust. J. Anim. Sci. 15(2):266-273.

Chrastil, J. 1990. Table molecular weights of rice oryzenin and starch components. J. Agric. Food Chem. 38:1804.

Economic Survey of Pakistan 2005-2006. Government of Pakistan Finance Division. Economic Advisor Wing, Islamabad. pp. 10-11.

Hamilton, C. R. and D. Kirstein. 2003. Does rancidity, as measured by peroxide value, Affect animal Performance. http://www.darlingii.com/product/documents/pveffectanimalspro.pdf.

Hussien, A. and F. H. Kratzer. 1982. Effect of rancidity on the feeding values of rice bran for chickens. Poult. Sci. 61:2450-2455.

Jadhao, S. B., M. Chandramoni, M. Tiwari and M. Y. Khan. 1999. Efficiency of utilization of energy from maize- and rice bran diets in old White Leghorn and Rhode Island Red laying hens. Br. Poult. Sci. 40:275-283.

Khalique, A., K. P. Lone, A. D. Khan and T. N. Pasha. 2006. Treatments effect on biological values of defatted rice polishings. Asian-Aust. J. Anim. Sci. 19(2):209-216.

Kirk, R. S. and R. Sawyer. 1991. Pearson's composition and analysis of foods. 9th edition. Harlow : AWL. USA, pp. 25-26.

Leeson, S. and J. D. Summer. 2001. Nutrition of chicken. University Books, P.O. Box 1326, Guelph, Ontario, Canada, pp. 67-68.

Loosli, J. K., J. O. Pena, L. A. Ynalvez and V. Villegos. 1954. The digestibility by swine of rice bran, copra meal, coconut meal, coconut residue, and two concentrate mixtures. The Philippine Agriculturist 38:191-196.

Lone, K. P., A. Khalique, T. N. Pasha and A. D. Khan. 2003. Chemical composition and nutritional evaluation of variously treated defatted rice polishing for broiler feeding. Asian-Aust. J. Anim. Sci. 16(6):873--879.

Mahatab, N. 1985. Variability in chemical composition of rice

bran. Poult. Advisor. 18:39-41.

Malekian, F., R. M. Rao, W. Prinyawiwatkul, W. E. Marshall, M. Windhauser and M. Ahmedna. 2000. Lipase and lipoxygenase activity, functionality and nutrient losses in rice bran during storage. Louisiana Agri. Exp. Station. LSU Agri. Centre. Tech. Bulletin 870:51-52.

Miller, M. R. and K. J. Reinecke. 1984. Proper Expression of metabolizable energy in avian energetics. Condor 86:396-400.

Ramezanzadeh, F. M., R. M. Rao, W. Prinyawiwatkul, W. E. Marshall and M. Windhauser. 1999 a. Prevention of hydrolytic rancidity in rice bran during storage. J. Agric. Food Chem. 47: 3050-3052.

Ramezanzadeh, F. M., R. M. Rao, W. Prinyawiwatkul, W. E. Marshall and M. Windhauser. 2000. Effects of microwave heat, packaging, and storage temperature on fatty acid and proximate compositions in rice bran. J. Agric. Food Chem. 48: 464-467.

Randall, J. M., R. N. Sayre, W. G. Schultz, R. Y. Fong, A. P. Mossman, R. E. Tribelhorn and R. M. Saunders. 1985. Rice bran stabilization by extrusion cooking for extraction of edible oil. J. Food Sci. 50:361-364.

Salih, A. M., D. M. Smith, J. F. Price and L. E. Dawson. 1987. Modified extraction 2-thiobarbituric acid method for measuring lipid oxidation in poultry. Poult. Sci. 66:1483-1488.

Sarkar, S. and D. K. Bhattacharyya. 1989. Studies on characteristics of rice bran. J. Oil Tech. Assoc. India. 21:11-12.

Scott, M. L., M. C. Nesheim and R. J. Young. 1976. Nutrition of chicken. M.L. Scott and Assoc., Ithaca, NY., USA., pp. 88-89.

Seiden, M. T. and L. Pfander. 1957. Nutritive and feeding value of RP for poultry. Poult. Sci. 29:1635.

Sibbald, I. R. 1976. A bioassay for true metabolizable energy in feedstuffs. Poult. Sci. 55:303-308.

Wadsworth, J. I. and S. P. Koltun. 1986. Physiochemical properties and cooking quality of microwave dried rice. J. Agric. Food Chem. 39:1860-1862.

Warren, B. E. and J. Farrel. 1990. The nutritive value of full-fat and defatted Australian rice bran. Anim. Feed Sci. and Tech. 27:219-228.

Yeo, H. and T. Shibamoto. 1991. Effect of moisture content on the Millard browning model system upon microwave irradiation. J. Agri. Food Chem. 39:1860-1862.