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Assessment of Feeding Value of Processed Rice Husk for Lohi Sheep in Growing Phase

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ABSTRACT

The present project was envisaged by using rice husk as a substrate for processing with the objective to produce a nutritionally enriched bulk feed ingredient and to explore its potential as wheat bran replacer in total mixed rations for the ruminants. For this purpose rice husk was subjected to different processing techniques using acid, alkali, water treatment and fermentation to prepare processed moiety on pilot scale. All these processed materials were included in experimental ration at a fixed level (20 %). All iso-caloric and iso-nitrogenous rations were offered to experimental animals (n=36, 22 male 14 female Lohi sheep almost evenly distributed in experimental groups) having almost uniform body weight (BW). During 60 days of the trial, no significant difference (p =0.067) in the daily feed intake among the different experimental groups was recorded. Maximum feed consumption was recorded in HT (hydrothermal treatment) 1096.69±26.8 (mean± SE) while lowest in NC (untreated husk) 974.91±18.8 followed by 1069±28 in FT (Fermented), 1045.81±27.7 in BT 1042.47±33 in AT and 1032.17±32 in PC group. A significant difference (p=0.039) in the weekly body weight gain (BWG) was recorded among the experimental groups. The highest weight gain was found in PC (0.977±0.75) followed by FT (0.972±0.71), AT (0.931±0.65) and BT (0.92± 0.53) while lowest was recorded in HT (0.70±0.603) and NC (0.808±0.088). The FCR calculated was found to be significantly (p=.000) different in all the six experimental groups. Minimum FCR was found in HT (7.68±0.64) followed by an ascending trend in AT (8.0 ±0.675), BT (8.09±0.833), NC (9.92±0.64), HT (10.645±0.675) and in PC (11.684±0.804) group. No mortality was observed. It can be concluded that rice husk can be successfully processed and can replace the wheat bran. Moreover, fermented husk by using *Pleurotus florida* can process rice husk into a nutritionally dense ingredient.

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Authors' Contribution
RN executed the experimental work. ZH worked on renal data analysis. SN designed ration formulations. MT helped in preparation of manuscript. ASH supervised the work.

Key words
Fermentation, FCR, Acid, Alkali, Crude protein

INTRODUCTION

Pakistan basically falls into the category of an agricultural country and its economy mainly relies on agriculture and livestock production. But our livestock are still underfed as they are facing 28% TDN and 55% DCP deficiency. The production potential of our animals can be optimized if feed stuffs are available according to the requirements of animals. More area is being utilized for housing and growing cash crops, while there is an annual reduction in the area available for agriculture. So, there is due need to upgrade presently available feed resources in this context, Rice is the staple food for more than half of the world's population. Pakistan produces 6748 million tons of rice annually, almost 20 % of which is husk (Pakistan Economic Survey, 2014). Green and dry roughages are the most important livestock feed in the country. The dry roughages are comparatively much cheaper as compared to green fodders and are usually the cereal crops residues in the form of straws, stover and husk. The present forage production is not coping with the feeding requirements of livestock in Pakistan. Pakistan is deficient by 40% in forages and 80% in concentrate feed (Pasha, 1998). Stresses for the exploitation of new feed resources and the interest for utilization of low quality crop residues like rice husk as an animal feed have increased.

These crop residues have poor nutritive value (low CP, high lignin content), characteristics that lead to poor intake and ultimately hindrance in digestibility. The high silica content present in the rice husk is a major barrier to its digestion and prevents parenchymal tissue from degradation (Agbagla *et al*., 2003). The rice husk has 20% silica presents in outer epidermal wall, which increases the abrasive character of rice husk (Park *et al*., 2003) silica exists as a highly compact carbon-silicon composite. Ligno-cellulosic bonding further makes it harder for digestion. Although rice husk is potential animal feed very few studies on its varietal differences, chemical treatment effects, response to solid state fermentation and *in vivo* feeding trials have been conducted in Pakistan.

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Biochemical conversion of lingo-cellulosic biomass into value added products is a subject of great interest. To achieve this purpose, it is important that the structure of the cellulosic biomass should be modified in such a manner, that they become accessible to enzymatic degradation (Mosier *et al*., 2005). Various chemical and biological treatments involve these structural changes, which result in high nutrient in less time.

Physical and chemical treatments like acid, alkali and steam under pressure treatments break covalent and non-covalent bonds between ligno-cellulosic components; these possess the capacity to hydrolyze hemicellulose and to some extent de-lignify the rice husk. Biological treatment of ligno-cellulosic material, solid state fermentation using white fungi improve its protein content and digestibility. This degradation is mentioned by the lignin degrading enzymes and auxiliary enzymes secreted mainly by white rot fungi (Ang *et al*., 2009).

The livestock of Pakistan are producing below their optimum potential because of the poor availability of fodder in terms of quantity as well as quality. By using the value added crop residues in the diet of cattle, it will enhance the production (milk/meat) of animals and help overcome the shortage of green fodder in lean periods and ensure consistent supply of feed for the livestock, consequently improving their health and the health of the under nourished people (Sarnklong *et al*., 2010).

The objective of the present studies is to explore the prospectus of chemical and biologically treated husk as a feed stuff for ruminants.

MATERIALS AND METHODS

Alkali and acid treatment

The husk of basmati rice (*Oryza sativa*) was procured from a local threshing mill and brought to the fermentation laboratory of Biochemistry, UVAS, and Lahore.The untreated husk have 8.9 % moisture. Alkali treatment was carried using 4 % NaOH for 24 h at the ambient temperature of 25°C. The husk to NaOH pre-optimized ratio was set at 2:1 *i.e.,* the ratio is calculated on weight basis. After 24 h no residual alkali was present in mixture.

In the second treatment rice husk was treated by using 0.5N H_2SO_4 for 24 h at the same temperature mentioned above for the alkali treatment. The pre-optimized ratio of husk to acid was 3:1. Both acid and alkali treated samples were air dried for 24 h and analyzed for the fiber content, CP, and total Ash content (AOAC, 1990).

Hydro thermal treatment

For this application water was added to the husk at pre-optimized husk to water ratio of 1:3. Then this material was boiled for a period of 60 min. Very little residual water was present after the boiling, and the material was then air dried for two days at 25°C (room temp). Hygrometer was used to measure humidity and maintained at 27 % .

Solid state fermentation

Untreated rice husk was fermented by using *Pleurotus florida* as the fermentative organism at 28°C in the dark for 21 days without supplementation. Conditions for fermentation were pre-optimized. A basal media was added to ensure moisture content of 35%. The fermentation was carried out in wide mouth plastic containers and agitated once in 24 h. Containers were sterilized using ethanol before the commencement of the fermentation process. Fermentation period in present study was 30 days.

All treated samples were subjected to chemical composition for CP (crude fiber), NDF (neutral detergent fiber), ADF (acid detergent fiber), TDN (total digestible nutrients), EE (ether extract) and ash contents and these compositions were used as requisite for formulation of experimental rations. Large scale preparation of total mixed ration was carried out.

To determine feeding value of all above treated rice husk, a feeding trial of 60 days was conducted at the Ravi campus Pattoki. Before the trial, 10 days were given as preliminary period to eliminate residues of feed already consuming and to acclimatize with experimental diet.

Feeding trials of Lohi sheep

The objective of this study was to use treated rice husk as a cheap source of dietary ingredient of small ruminant feed. All processed rice husks were included in a concentrate ration to determine feeding value and digestibility. For this purpose, 36 sheep of mixed sex (22 males and 14 female) but of almost uniform weight and age were randomly divided into 6 groups. Sexes are almost uniformly distributed, each group having 4 males and 2 females except group FT having 4 females and one male, each having three replicates.

Experimental animals and their management

All the experimental Lohi sheep were 8-9 months old with an average body weight of 24±5 kg at the beginning of the experiment. There was no significant difference between initial live weights of all experimental animals. Sheep were fed *ad libitum* twice daily (09.00 and 16.00 hours) in cemented mangers. After the morning feeding all sheep were let loose in an open paddock throughout the experimental period except during extreme weather. Sheep were housed and managed in replicates in a well ventilated shed with concrete floor. Daily sweeping and cleaning of floors was practiced to maintain good hygienic environment (Mahmoud and El-Bordeny, 2016). Clean and fresh water was offered daily.

Table I.- Ration formulations of various groups.

Ingredients (%)	Positive control (PC)	Alkali treated (BT)	Acid treated (AT)	Hydrothermal treated (HT)	Fermented (FT)	Negative control (NC)
Corn, grain	21.00	21.00	22.00	22.00	22.00	20.00
Wheat bran	14.00	15.00	15.00	15	15.00	16.00
Rice polish	10.00	11.00	11.00	10	12.00	10.00
Molasses (S Cane)	7.00	7.00	7.00	7.00	7.00	7.00
Canola meal	8.00	8.00	8.00	8.00	8.00	8.00
Sunflower Ml	8.00	8.00	8.00	8.00	7.00	8.00
Corn gluten Ml 30%	10.00	8.00	7.00	8.00	7.00	9.00
Cmn salt NaCl	0.50	0.50	0.50	0.50	0.50	0.50
Sodium bi carbonate	0.50	0.50	0.50	0..50	0.50	0.50
Min mix (ruminants)	1.00	1.00	1.00	1	1.00	1.00
Wheat straw	20.00	-	-	-	-	-
Rice husk	-	20.00 (RH)	20.00 (RH)	20.00 (RH)	20.00 (RH)	20.00 (RH)

Feed intake of every replicate was recorded daily by measuring the amount of refusal before the morning feeding. Sheep were weighed weekly to monitor the growth rate after restriction of feed and water intake for 16 hours throughout the experimental period by using an electronic scale. Data thus collected were used to calculate feed efficiency. Composition of experimental rations is depicted in Table I, while nutrient profile is mentioned in Table II.

Lohi Sheep were weighed weekly to monitor the growth rate after restriction of feed and water intake for 16 h throughout the experimental period by using an electronic scale. Data thus collected were used to calculate feed efficiency.

Table II.- Nutritional profile of various experimental rations.

Parameter	PC	NC	AT	B T	HT	FH
CP	14.95	14.99	15.22	15.28	15.31	15.36
CF	14.77	13.03	13	11.08	12.20	12.83
NDF	14.59	14.75	9.57	10.41	14.54	14.06
ADF	9.45	11.29	5.30	7.66	11.87	12.22
TDN	64.65	62.72	64.75	65.15	65.02	66.07
E.E	3.91	3.77	3.91	3.95	3.88	4.04
M.E	2.30	2.21	2.26	2.28	2.15	2.29
ASH	6.57	7.06	7.41	7.60	7.05	7.23

CP, crude protein; CF, crude fiber; NDF, neutral detergent fiber; ADF, acid detergent fiber; TDN, total digestible nutrient; EE, ether extract; ME, metabolizable energy; PC, positive control with wheat bran in TMR (total mixed ration);FT, fermented husk; NC, untreated husk; BT, alkali treated husk; AT, acid treated husk; HT, hydrothermal treatment.

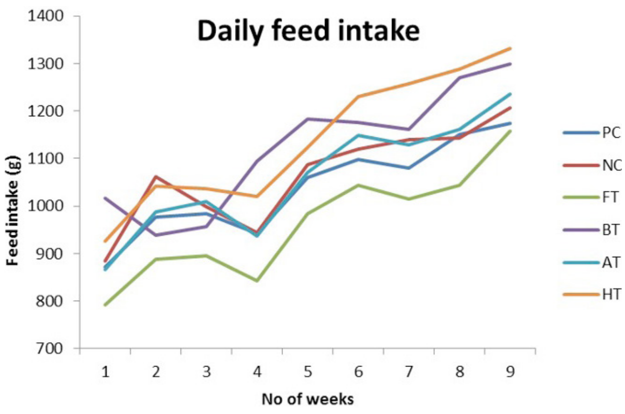

Fig. 1. Daily feed intake of different groups. PC, positive control with wheat bran in TMR (total mixed ration); FT, fermented husk; NC, untreated husk; BT, alkali treated husk; AT, acid treated husk.

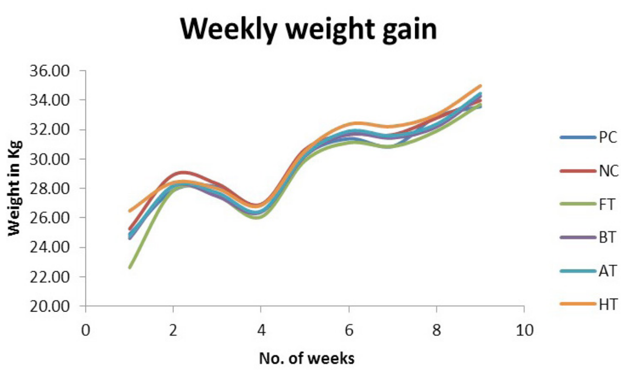

Fig. 2. Weekly weight gain of different groups. PC, positive control with wheat bran in TMR (total mixed ration); FT, fermented husk; NC, untreated husk; BT, alkali treated husk; AT, acid treated husk.

Table III.- Growth performance of Lohi sheep fed on differently experimental rations.

Parameters	PC	FT	NC	BT	AT	HT
Daily feed intake (g)	1032.17±32[a,b]	1069.12±28[a,b]	974.91±18.8[b]	1045.81±27[a,b]	1042.47±33[ab]	1096.69±26.8[a]
Weight gain (Kg)	0.98±0.07[a]	0.97±0.71[a]	0.81±.088[a,b]	0.92±0.53[a]	0.931±0.65[a]	0.70±0.60[b]
FCR	11.68±0.80[a]	7.68±0.64[f]	9.92±0.64[c]	8.09±0.83[e]	8.00±0.67[d]	10.645±0.67[b]

*, Means in the same row with same superscripts are not significantly different (P >0.05). PC, positive control with wheat bran in TMR; FT, fermented husk; NC, untreated husk; BT, alkali treated husk; AT, acid treated husk; HT, hydrothermal treatment.

Table IV.- Economics of the experimental ration.

	PC	FT	NC	BT	AT	HT
Cost of feed/day Rs.	23.92±1.32	23.32±1.06	21.45±1.34	23.27±1.85	22.88±0.93	23.98±1.02
Feed cost/Kg gain	199.3±15.23	168.9±14.85	214.5±16.32	177.63±15.56	172±10.02	239.8±17.4

PC, positive control with wheat bran in TMR (total mixed ration); FT, fermented husk; NC, untreated husk; BT, alkali treated husk; AT, acid treated husk; HT, hydrothermal treatment.

RESULTS AND DISCUSSION

Performance of differently processed feeds is illustrated in Table III. The total feed intake of all the six groups of Lohi sheep ranged between 975± 68 to 1092±77 grams per day and weekly weight gain ranges from 0.7±0.1 to 0.977±.052 Kg/week. Highest intake was found in water treated rice husk and the lowest was found with untreated rice husk (NC) negative control (975.68±68.7). This intake is in line with the results obtained earlier fattening trials of Lohi sheep (Jabbar and Anjum, 2008). Although for some foreign breeds such as *Omani* sheep showed an exceptionally high intake of 6.4±7.4% of body weight was reported El-Hag and Al-Shargi (1998). Initial weight gains of animals were significantly high (Table III) but the subsequent weight gain followed the uniform pattern as shown in Figure 1. This is perhaps due to the shifting of animals from grazing and consequently average daily gains follow the pattern which is in line with previous studies conducted on the same breed by Jabbar and Anjum (2008). Growth rate followed the linear pattern for all the six groups as shown in Figure 2. Lambs growth rate depends upon feed intake rather than the duration of the intake (Butterfield, 1988). In the present study growth rates obtained were almost the same as that of tropical breeds (Gatenby, 1986; Kusina *et al*., 1991), although they are slightly lower than those using conventional rations for the same breed (Jabbar and Anjum, 2008).

Rations in the present study were isocaloric and it was also found that high energy diets (High protein diets) were more efficient, as efficiency is the function of weight gain and dry matter intake. Interpretation is difficult as energy used for maintenance is not distinguished from energy used for weight gain. It is observed that high protein content of total mixed ration (Table II) results in the better values of feed conversion ratio (FCR), supported by the studies of Kusina *et al*. (1991) and Butterfield (1988). The FCR found in the current study were better than previously reported, for the same breed. The treatments increased the digestibility and palatability of rice husk which is proved in *in vitro* digestibility trials, although feed intake was reduced. Previous study using agricultural by products showed 11.5 and 12.4 FCR in sheep (El-Hag and Al-Shargi, 1995). Whereas diets based on Rhodes grass hay, Chesworth *et al*. (1996) showed a remarkably good FCR of 5.48 and 6.02. This study found significant difference between the groups shown in Table III. As far as the economy of rice husk (Table IV) was concerned it is comparable to the conventional ration. Water treated husk due to large intake and poor FCR was ranked as expensive. The current study fully supports the use of rice husk as a convenient replacer of conventional wheat straw.

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Statement of conflict of interest

Authors have declared no conflict of interest.

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