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Bioconversion of Wheat Bran to Biomass Protein through Metabiosis and its Biological Evaluation in Broiler Chicks

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ABSTRACT

Optimum growth conditions were determined for the production of biomass protein by culturing *Candida utilis* and *Brevibacterium flavum* on wheat bran. The biomass thus produced contained 35.97% crude protein and 30.18% true protein and sufficient quantity of essential amino acids that were limiting in substrate. The nutritional value of microbial biomass protein was determined in a six week feeding trial on broiler chicks by replacing 50% fish meal protein of control ration with biomass protein. The results revealed that weight gain, feed conversion ratio, protein efficiency ratio, meat protein and dressing percentage of chicks fed on biomass ration were quite comparable to the chicks on basal diet.

Key Words: Bioconversion; Wheat bran; Biomass; Metabiosis; Evaluation

INTRODUCTION

Cereals are main source of energy and protein for poultry as well as for human beings. But cereals are relatively poor in protein quality because of the deficiency of certain essential amino acids viz. lysine, arginine and threonine etc. Supplementation of plant protein with that of animal protein is necessary to balance the ration but this results in increased feeding cost. Increasing demand for protein supplements has led to search for non-conventional feeding sources. Single cell protein can play a pivotal role in this regard. Recent advances in biotechnology has led to some novel ways in the production of biomass protein by using various substrates such as wheat bran, rice polishing and other fibrous feed stuffs which are abundantly available. Microbes can contribute to supply of feed through fermentation. Microbial protein can be fed to poultry, livestock and human being. Through large scale industrial exploitation of this phenomenon to produce biomass by using various agricultural wastes seems to be the immediate solution to fulfill the protein deficiency gap in the country. This study was conducted to determine the suitability of wheat bran as a substrate for the production of biomass protein and to assess its nutritive value through chemical analysis and biological trial on broiler chicks.

MATERIALS AND METHODS

Before the start of the study, the proximate analysis of wheat bran was carried out (AOAC, 1984) and two organisms, *Candida (C.) utilis* and *Brevibacterium (B.) flavum* were obtained from the National Institute of Biotechnology and Genetic Engineering (NIBGE), Faisalabad and Japanese Federation of Culture Collection of Microorganisms, University of Tokyo, Japan, respectively. Cultures were maintained on their respective agar slants and inoculum media (NICMB, 1990). *C. utilis* and *B. flavum* were inoculated to their respective media[1] and incubated at 35^0C for three days, each time to determine the optimum conditions for carbon(C): Nitrogen (N) ratio, substrate:water ratio, treatment of substrate with 5% H_2SO_4, time of incubation of second organism, time of addition of corn steep liquor and time of addition of molasses for optimum growth of microorganisms. Based on the findings of these trials, a growth media[2] was finalized for fermentation of wheat bran in a 500 litre (L) horizontal fermentar using 200 L capacity.

The medium was sterilized by steam at 15 lbs PSI (per square inch) for 30 minutes and it was allowed to cool at 35^0C. The inoculum of *C. utilis* was prepared in 50 L fermenter. It was shifted aseptically to growth medium in 500 L horizontal fermenter. Clean air was

[1] For *C. utilis*/1000 ml of media: wheat bran, 30 gm; urea 0.30 gm; KH_2PO_4. $7H_2O$, 1.0 gm;
MgSO4.$7H_2O$, 0.5 gm; KCl, 0.5 gm; FeSO4. $7H_2O$, 0.50 gm; pH adjusted at 6. For *B. flavum*/1000 ml of media: yeast extract, 2.0 gm; Peptones, 5.0 gm; glucose, 10.0 gm, pH adjusted at 7.

[2] Contents/200 L: wheat bran, 12 Kg; urea, 492 gm; KH_2PO_4. $7H_2O$, 400 gm; $MgSo_4$.
$7H_2O$, 10 gm; KCl, 5 gm; $CaCl_2$, 10 gm; $FeSO_4$. $7H_2O$, 2 gm; pH adjusted at 6.

supplied at the rate of 200 L/minute by air compressor. The fementer was allowed to work at 50-60 cycle/minute for 72 hours at 35^{0}C.

Corn steep liquor was added after 48 hours of incubation while *B. flavum* and molasses were added after 72 hours of incubation and pH of medium was raised to 7.0. The fermentation process was terminated after 96 hours and the biomass was harvested by steaming for 15 minutes. It was dried and analyzed for proximate composition and calorific value (AOAC, 1984).

The nutritional quality of the dried biomass was evaluated in a feeding trial of six weeks on 60, day-old broiler chicks of mixed sexes. On the 1st day, the birds were wing banded for identification and randomly divided into six replicates of 10 chicks each. Two isonitrogenous (23.5%) and isocaloric (3200 Kcal/kg) broiler rations (Table I) were prepared and each of the rations was randomly alloted to three replicates of 10 chicks each. The birds were kept in room on standard managemental conditions and fed *ad libitum* on these rations. During the experiment, weight gain and feed consumption for individual birds were recorded and feed: gain ratio and protein efficiency ratio were worked out.

The data thus collected were analysed statistically using ANOVA and significant differences were compared by Duncan's Multiple Range Test (Steel & Torrie, 1981).

Table I. Composition of experimental rations (Athar *et al.*, 1994)

Description	Control	Biomass
Maize	51.20	50.95
Cotton seed meal	6.00	6.00
Rape seed meal	2.00	2.00
Corn gluten (30%)	4.00	-----
Corn gluten (60%)	4.30	4.30
Soybean meal	10.75	10.75
Fish meal	12.00	6.00
Biomass	------	10.00
Blood meal	2.00	2.00
DCP	0.25	0.25
Molasses	4.00	3.00
Soy oil	3.00	3.33
$CaCO_3$	0.25	0.55
Premix	0.25	0.25
Total	100.00	100.00
Crude protein	23.09	23.00
Metabolizable energy (Kcal/kg)	3273.17	3215.60

Table II. Optimum conditions for fermentation

Conditions	Level used	Respective crude protein
Substrate:water ratio	5,6,8 gm in 100 ml water	19.65, 20.15, 19.40
C:N ratio	7.5:1, 10:1, 12.5:1	25.22, 25.39, 26.45
Substrate treatment with 5% H_2SO_4	1.0, 1.5, 2.0 ml/gm	26.44, 26.82, 27.03
Addition of corn liquor (5%)	24, 36, 48 hours	26.68, 28.45, 30.19
Time of inoculation (2nd organism)	72, 84, 96 hours	28.45, 28.14, 32.0
Addition of 5% mollasses	60, 72, 84 hours	26.14, 37.68, 32.66

Table III. Chemical composition of wheat bran and biomass

Nutrient	Wheat bran (%)	Biomass (%)
Moisture	7.48	9.67
Crude protein	12.23	35.67
Ether extract	4.86	9.08
Crude fibre	6.25	16.32
Ash	9.56	14.26
Nitrogen free extract	60.00	14.65
Calorific value (Kcal/kg)	------	2635.70
True protein	9.62	30.15

RESULTS AND DISCUSSION

The results of optimum conditions with their respective levels used are shown in Table II and those of proximate analysis, true protein and calorific value of both substrate and biomass in Table III. Similar optimum conditions were reported by Bashir (1990) for the production of biomass from wheat bran using. *C. utilis* as a fermentive organism. He obtained maximum biomass protein in shacked medium with 6% (W/V) substrate:water ratio at pH 6.0 and 35^{0}C. *C. utilis* has also been used for fermentation of rice polishing with a maximum crude protein (27.8%) at

9% substrate level after 72 hours of incubation at pH 4 and 35^{0}C (Kiani, 1989).

Performance trial. It is evident from the results (Table IV) that there was no difference among various performance parameters which is in agreement with the finding of Lee and Yang (1982) who replaced 20 and 40% of the protein of soybean oil meal with a yeast containing 45.6% crude protein. Likewise, there was no difference in the protein efficiency of chicks fed biomass obtained from fermented beet pulp using *C. utilis* and *B. flavum* (Safdar, 1995). Ather *et al.* (1994) also fermented beet pulp and found non-significant results with respect to quality of biomass protein in terms of digestibility, net protein utilization and biological value as compared to the control ration. Similarly, non-significant differences of dressing percentage and meat protein between the chicks fed on control and biomass (*Saccharomyces cervisiae* produced) containing rations (Sokolova *et al.*, 1985). They reported that there was no adverse effect of biomass on the meat, rather inclusion of biomass to the broiler ration at 3% level increased the yield of first grade meat. This indicates that biomass can be helpful in improving the meat quality.

Table IV. Performance of broiler chicks fed on control and biomass rations

Description	Rations¤	
	Control	Biomass
Total weight gain/chick(gm)	1410.00	1390.50
Total feed consumed (gm)	1578.60	1435.00
Feed conversion ratio	3.40	3.15
Protein efficiency ratio	3.19	3.04
Dressing percentage (%)	59.22	57.78
Meat protein (%)	18.11	19.47

¤see Table III

CONCLUSIONS

Biomass has potential to replace 50% of the fishmeal because of its high protein contents and good nutritive value. Therefore, biomass production by using other sources like agricultural wastes as substrate seems to be an appropriate solution to bridge the protein deficiency gap in the country.

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