THE NUTRITIVE VALUE OF BUCKWHEAT *(FAGOPYRUM ESCULENTUM)*

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Summary

Buckwheat was shown to be superior to oats and wheat for rat growth. Supplementation with several amino acids indicated that isoleucine was first limiting for growth.

Pigs grew fastest on buckwheat supplemented with 11% meat meal plus 0.17% lysine HCL. Pigs on unsupplemented buckwheat diet grew at a similar rate to those on an unsupplemented 12% crude protein wheat diet, Addition of lysine to buckwheat improved feed conversion but not growth rate.

Ie INTRODUCTION

Buckwheat *(Fagopyrum esculentum)* is not a cereal *(Gramineae)* but a member of the family *Polygonaceae*. It is a summer annual, has a short growing season of 10 to 12 weeks, and appears to have a special capacity to grow in cool climates under a wide range of soil conditions. It can grow on soils of insufficient fertility for economic yields of many cereals and on the Southern Tablelands has produced from 750 to 3000 kg/ha (Matheson 1974, pers. comm.). It is reputed to have a protein of high quality (Sure, 1955). Although most of the present Australian production is exported to Japan for human consumption, in the future there may be sufficient available for animal feeds.

This paper reports experiments with pigs and rats designed to assess the nutritional value of Australian-grown buckwheat.

II. MATERIALS AND METHODS

Individual weanling male rats (5 or 6 per treatment) were offered *ad lib* for 10 or 12 d a control (fish/meat meal and wheat), a monocereal, or a buckwheat diet supplemented with free amino acids that on the basis of chemical analysis appeared to limit growth rate.

Thirty Large White x Landrace castrated male pigs (15 kg) were placed in individual pens in a temperature controlled (22^0C) piggery. Following a period of adjustment on a commercial grower diet five pigs (18 kg) were allocated to each of the following six diets: A. Buckwheat; Be Buckwheat + 0.5% lysine HCL; C. Buckwheat + 11% meat meal + 0.16% lysine HCL; De Buckwheat + 15% sunflower meal + 0.17% lysine HCL; E. Wheat (12% crude protein); Fe Wheat (17% crude protein) + 0.6% lysine HCL. A mineral and vitamin supplement, including bone meal, was added in appropriate amounts to diets of rats and pigs. Restricted amounts of each pig diet were allocated on a daily basis using the formula, digestible energy (MJ) = $1.36\ W(kg)^{0.75}$.

Apparent digestibility of dry matter, nitrogen and energy of buckwheat was determined by total collection of faeces from each of 4 pigs (20 kg liveweight) in metabolism crates over 5 d after an adjustment period of 4 de Each pig was offered daily 1 kg of buckwheat.

Chemical analysis of feeds and excreta followed the methods of the A.O.A.C. (1960) except for neutral detergent fibre (Van Soest & Wine, 1967). Amino acid analyses were determined on the acid hydrolysates (Spackman, Stein & Moore, 1958) using a TSM-1 Technicon Amino Acid Analyser.

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III. RESULTS

Chemical composition of buckwheat and other grains and some biological measurements are shown in Table 1. Despite the high fibre content of buckwheat apparent digestibility of dry matter, energy and nitrogen were 'higher than anticipated. Amino acid profiles suggested that the protein quality of buckwheat was superior to that of wheat and oats.

TABLE 1

Chemical composition (air-dry basis) and some biological measurements of buckwheat, oats and wheat

		Buckwheat	Oats	Wheat
Protein (N x 6.25)	(%)	12.6	9.8	12.0
Ether extract	(%)	4.0	5.5	
Neutral Detergent Fibre	(%)	19.5	30.6	
Ash	(%)	2.0	4.0	
Moisture	(%)	12.4	10.1	
Digestible energy	(MJ/kg)	1.15		
N digestibility	(%)	74.3		
Dry matter digestibility	(%)	73.7		
Arginine	(%)	1.13	0.7	0.53
Isoleucine	(%)	0.35	0.35	0.29
Leucine	(%)	0.77	0.8	0.77
Lysine	(%)	0.58	0.37	0.29
Methionine	(%)	0.32	0.28	0.17
Threonine	(%)	0.36	0.33	0.23
Valine	(%)	0.79	0.53	0.65

Statistical analysis of growth and feed conversion measurements on rats showed that there was a significant effect ($P<0.01$) of diet (Table 2). Buckwheat when fed without a protein supplement was always superior to the two cereal grains used for comparison (Experiment 1). Isoleucine appeared to be the only amino acid limiting growth of weanling rats on buckwheat (diet 10).

The pig experiment was terminated after 54 d due to lack of buckwheat. After 50 d all pigs on Diet C had reached the target liveweight of 40 kge Data based on (i)observations made after 45 d and (ii)at a mean group liveweight of 32 kg are shown in Table 3. There was a significant effect ($P<0.01$) of diet on growth rate and feed conversion.

Addition of free lysine to buckwheat did not increase pig growth but significantly improved feed conversion ($P<0.05$). Addition of meat meal (Diet C) gave outstanding results. Comparison of Diet A and Diet E suggests that for pigs buckwheat unsupplemented is not much better than wheat unsupplemented and feed conversion ratio was significantly' poorer ($P<0.05$) due to the lower digestible energy content of buckwheat.

IV. DISCUSSION

The lack of a significant growth response by pigs to the addition of lysine HCL to buckwheat is explained by the observation that the first, and apparently only limiting amino acid for ratgrowth was isoleucine. However, the good performance by rats on unsupplemented buckwheat compared with wheat was not supported in the pig experiment where there appeared to be no appreciable difference in growth of pigs

TABLE 2

Performance of weanling rats on diets (1 to 11), based on buckwheat (B) with amino acids (aa) with or without leucine (L) and isoleucine (IL). Wheat (W) and oats (O) were also fed as monocereal diets.

DIET	B (1)	O (2)	W (3)	B + aa* (4)	O + aa* (5)	W + aa* (6)	Control
Experiment I							
Growth rate (g/10 d)	$49.9^{a\dagger}$	14.2^{b}	25.8^{c}	46.0^{a}	21.7^{b}	50.4^{a}	54.2^{a}
Feed conversion	3.3^{a}	6.7^{b}	4.8^{c}	2.9^{a}	4.4^{c}	2.4^{a}	2.6^{a}

DIET	B (8)	B + aa** (9)	B + aa** - IL (10)	B + aa** - L (11)
Experiment II				
Growth rate (g/10 d)	43.8^{a}	53.5^{b}	44.1^{a}	50.2^{b}
Feed conversion	3.0^{a}	3.9^{a}	3.2^{a}	2.9^{a}

* Lysine, methionine, threonine. ** Lysine, methionine, threonine, isoleucine, leucine, valine.
† Values with the same superscript within each line are not significantly different (P>0.05).

TABLE 3

Performance of 5 pigs (each 18 kg) per treatment observed after 45 d, and at 32 kg

DIET	A	B	C	D	E	F
	*					
Growth to 32 kg (g/d)	241^{a}	289^{a}	434^{b}	290^{ac}	269^{a}	325^{c}
Feed conversion	5.2^{a}	4.3^{b}	2.9^{c}	4.3^{b}	3.9^{b}	3.3^{bc}
Growth after 45 d (g/d)	221^{a}	249^{ac}	431^{b}	263^{c}	239^{ac}	320^{d}
Feed conversion	5.2^{a}	4.6^{b}	2.9^{c}	3.8^{d}	4.1^{bd}	3.2^{c}

* Values with the same superscript within each line are not significantly different (P>0.05)

on buckwheat and on a 12% crude protein wheat. Feed conversion on the wheat diet was better.

The good performance of pigs on buckwheat with only a small amount of meat meal and lysine compared with that on buckwheat with sunflower meal and lysine calculated to provide similar amounts of protein and lysine indicated the inferiority of sunflower meal as a protein supplement. However it is possible that isoleucine may still have been deficient in the meat meal diet (Packham & Payne, 1973), and performance of the pigs may have been improved by addition of this amino acid.

Wheat of 17% crude protein did not provide the excellent growth of pigs previously observed on a similar wheat of almost identical essential amino acid-composition (Ivan, Farrell & Edey, 1975). Although free lysine was added to bring the total calculated lysine to 0.85%, analysis showed that the value was only 0.73%. This is substantially less than the recent suggested requirement for lysine by growing pigs (Lewis & Annison, 1974).

On the basis of amino acid analysis buckwheat protein is of much higher quality than that normally found in the cereal grains. The apparent digestibility of dry matter nitrogen and energy is not as high as found in several other grains but can be explained on the basis of fibre content, which is probably a large component of the hulls.

Although more work is required to determine the most appropriate supplement to buckwheat for optimum utilization of its protein and energy by pigs, it does appear to have potential as both a protein and energy source as suggested by the studies of van Wyk, Varbeek & Oosthuizen (1952).

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