Nontraditional Feed Sources for Use in Swine Production

P.A. Thacker · R.N. Kirkwood

Butterworths

NONTRADITIONAL FEED SOURCES

FOR USE IN

SWINE PRODUCTION

P.A. Thacker and R.N. Kirkwood

Department of Animal & Poultry Science
University of Saskatchewan
Saskatoon, Saskatchewan

Butterworths

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CONTRIBUTORS

Dr. Frank X. Aherne
Department of Animal Science
University of Alberta
Edmonton, Alberta

Dr. Derek M. Anderson
Department of Animal Science
Nova Scotia Agricultural College
Truro, Nova Scotia

Dr. Henry S. Bayley
Department of Nutrition
University of Guelph
Guelph, Ontario

Mr. Ron B. Bazylo
Regional Swine Specialist
Alberta Agriculture
Vermillion, Alberta

Dr. Dick M. Beames
Department of Animal Science
University of British Columbia
Vancouver, B.C.

Dr. J. Milt Bell
Department of Animal Science
University of Saskatchewan
Saskatoon, Saskatchewan

Dr. John P. Bowland
Department of Animal Science
University of Alberta
Edmonton, Alberta

Dr. Adrian G. Castell
Swine Nutrition Section
Agric. Canada Research Station
Brandon, Manitoba

Dr. Des J.A. Cole
Department of Agriculture
University of Nottingham
Sutton Bonington, Leicester

Dr. James D. Chapman
Alltech Biotechnology Centre
3031 Catnip Hill
Nicholasville, Kentucky

Mr. Craig S. Darroch
Department of Animal Science
University of Saskatchewan
Saskatoon, Saskatchewan

Ms. Adrienne C. DeSchutter
Livestock Section
Ridgetown College of Agric.
Ridgetown, Ontario

Dr. William E. Dinusson
Department of Animal Science
North Dakota State University
Fargo, North Dakota

Dr. Sandra A. Edwards
Pig Lead Centre
N. Scotland College of Agric.
Aberdeen, Scotland

Dr. T.E. Ekpenyong
Department of Animal Science
University of Ibadan
Ibadan, Nigeria

Dr. David J. Farrell
Department of Animal Science
University of New England
Armidale, New South Wales

Dr. O.M. Hale
Department of Animal Science
Coastal Plain Station
Tifton, Georgia

Dr. Keith D. Haydon
Department of Animal Science
Coastal Plain Station
Tifton, Georgia

Dr. Palmer Holden
Department of Animal Science
Iowa State University
Ames, Iowa

Dr. Keith Hutton
Coprice Division
Rice Growers, Co-operative
Leeton, New South Wales

Dr. Ray H. King
Department of Agriculture
Animal Research Institute
Werribee, Victoria

Dr. Steve Leeson
Department of Animal Science
University of Guelph
Guelph, Ontario

Dr. R. Maitland Livingstone
Dept. of Animal Husbandry
Rowett Research Institute
Bucksburn, Aberdeen

Dr. Annette C. Longland
AFRC Institute
Shinfield, Reading
Berkshire, United Kingdom

Dr. A. Graham Low
AFRC Institute
Shinfield, Reading
Berkshire, United Kingdom

Dr. T. Pearse Lyons
Alltech Biotechnology Centre
3031 Catnip Hill
Nicholasville, Kentucky

Mr. W. Ian Magowan
Swine Nutritionist
Vigor Feeds Division
Edmonton, Alberta

Dr. Donald C. Mahan
Department of Animal Science
Ohio State University
Columbus, Ohio

Dr. Charles V. Maxwell
Department of Animal Science
Oklahoma State University
Stillwater, Oklahoma

Dr. Elwyn R. Miller
Department of Animal Science
Michigan State University
East Lansing, Michigan

Mr. Jim R. Morris
Department of Animal Science
Ridgetown College of Agric.
Ridgetown, Ontario

Dr. Surendra S. Negi
Indian Vet. Research Institute
Regional Station
Palampur, India

Dr. H. William Newland
Department of Animal Science
Ohio State University
Wooster, Ohio

Dr. G. Larry Newton
Department of Animal Science
University of Georgia
Tifton, Georgia

Dr. Emmanuel Nwokolo
Department of Animal Science
University of Alberta
Edmonton, Alberta

Dr. O.L. Oke
Chemistry Department
University of Ife
Ife-Ife, Nigeria

Ms. Daphine J. Peer
Animal Industry Branch
Ontario Ministry of Agriculture
Fergus, Ontario

Mr. Steven V. Radecki
Department of Animal Science
Michigan State University
East Lansing, Michigan

Dr. Velmurugu Ravindran
Department of Animal Science
University of Peradeniya
Peradeniya, Sri Lanka

Mr. J.P. Rodriquez
Nutro Products Incorporated
445 Wilson Way
Industry, California

Dr. Gerry C. Shurson
Department of Animal Science
Ohio State University
Columbus, Ohio

Dr. T.D. Tanksley, Jr.
Department of Animal Science
Texas A & M University
Betram, Texas

Dr. Phil A. Thacker
Department of Animal Science
University of Saskatchewan
Saskatoon, Saskatchewan

Dr. Peter J. Thorne
ODNRI
Culham, Abingdon
Oxford, United Kingdom

Mr. Ted A. Van Lunen
Swine Nutrition Section
Agric. Canada Research Station
Nappan, Nova Scotia

Dr. Richard C. Wahlstrom
Department of Animal Science
South Dakota State University
Brookings, South Dakota

Mr. Derek G. Waterworth
ICI Biological Products
Billingham, Cleveland
England

Dr. Julian Wiseman
Department of Agriculture
University of Nottingham
Sutton Bonington, Leicester

PREFACE

Feed represents the greatest single expense associated with raising pigs to market weight. Therefore, it may be possible to improve the economics of swine production if this cost can be reduced without detriment to pig performance. Pigs are "opportunity feeders" and have the ability to consume all manner of feedstuffs. However, in recent times, the ingredient list for swine rations has become fairly limited, and the majority of diets fed to pigs are based on a few staples, such as corn, wheat, barley and soybean meal.

There are many alternative sources of dietary energy and protein that may have potential for use in swine production. However, the successful incorporation of these unfamiliar nutrient sources into animal diets is limited by the availability of sufficient information on which to base feeding recommendations. The editors of this volume have attempted to fill this gap in the literature by presenting separate and self-contained chapters for over fifty nontraditional feedstuffs.

Each chapter was prepared by experts in their respective feed source areas and covers the background and history of the feed as well as providing information on its nutrient content and the presence of any anti-nutritional factors that might limit its nutritional value. Each chapter concludes with specific recommendations concerning the best use of the feedstuff in question and provides guidelines for optimum inclusion rates. As such, the book should provide a handy reference text for swine producers, feed industry nutritionists, extension personnel, university students and swine researchers.

We wish to express our sincere appreciation to Ms. Fran Teitge for her many hours spent preparing the text for publication and to the University of Saskatchewan for financial support during its preparation. Finally, we wish to thank each contributor, whose efforts made the volume possible.

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CHAPTER 1

Alfalfa Meal

P.A. Thacker

INTRODUCTION

Alfalfa is of interest as a potential feedstuff for swine because it produces high yields of protein and is not consumed directly by humans. In the future, high quality protein sources such as soybean meal may become less available for livestock feeding because of greater direct human utilization. This may result in a greater dependency on more fibrous feedstuffs such as alfalfa for non-ruminant animals.

Unfortunately, there are problems associated with alfalfa which limit its usefulness as an ingredient in swine rations. The protein in alfalfa is poorly digested. Alfalfa has a low digestible energy content due to its high crude fiber content while toxins such as saponins and tannins reduce the growth rate of animals fed diets containing alfalfa. In addition, alfalfa is relatively unpalatable. Despite the negative factors present, there is still considerable interest in the use of alfalfa as a supplementary source of vitamins and as a component of gestation rations. Therefore, research is being conducted in an effort to overcome the problems associated with the feeding of alfalfa. If this work is successful, the use of alfalfa in swine rations may increase.

GROWING ALFALFA

Alfalfa (*Medicago species*) is one of the most popular forage crops grown throughout the world. It is adapted to a wide variety of soil and climatic conditions but grows particularly well on deep, well-drained, neutral soils (Goplen et al., 1982). Optimum temperatures for growth are 15 to 25°C during the day and 10 to 20°C at night. In addition, since alfalfa is a nitrogen fixing legume, proper inoculation eliminates the need for nitrogen fertilization.

Alfalfa is usually cut once or twice a year, although in very moist climates, three or four cuttings are possible. If the alfalfa is to be used as a protein supplement, cutting at the early bud stage is most appropriate, while for use as a roughage, cutting at the 10% bloom stage is recommended (Goplen et al., 1982). Under proper management, dry matter yields in excess of 7000 kg/ha are possible.

NUTRIENT CONTENT OF ALFALFA

The nutritional quality of alfalfa varies considerably due to stage of maturity, soil fertility, variety, physical handling and other factors. The most significant factor affecting the nutritional value of alfalfa is the growth stage at which it was cut. As the forage becomes more mature, it contains less protein and more fiber (National Academy of Science, 1972). The crude fiber content of alfalfa is extremely high compared to other commonly utilized feedstuffs. Since the pig has a simple stomach of relatively small capacity, it is less able to utilize crude fiber than are other types of farm livestock. Therefore, the digestible energy content of alfalfa is approximately half of that found in the common cereal grains (Table 1.1).

Table 1.1. Chemical Composition of Alfalfa (as fed)

	Alfalfa Hay[1]	Sun Cured Alfalfa Meal[1]	Dehydrated Alfalfa Meal[2]
Dry Matter (%)	91.4	90.7	92.0
Crude Protein (%)	15.5	17.6	17.4
Crude Fiber (%)	28.0	27.3	24.0
Ash (%)	9.0	9.6	----
Ether Extract (%)	1.7	2.1	2.8
D.E. (kcal/kg)	1419	1351	1880

[1]National Academy of Science, 1972.
[2]National Research Council, 1988.

Alfalfa ranges from 12 to 22% crude protein. Unfortunately, the protein in alfalfa is not very digestible. The high fiber content of alfalfa reduces the ability of digestive enzymes to gain access to the soluble cellular proteins. As a result, the protein in alfalfa is only about 60% digestible (Cheeke and Myer, 1975). Alfalfa contains a respectable amino acid balance and a reasonable level of lysine which is the limiting amino acid in most cereal grains (Table 1.2). However, because of the high fiber level, the availability of the lysine in alfalfa is low.

Table 1.2. Amino Acid Content of Alfalfa (% as fed)

	Alfalfa Hay[1]	Sun Cured Alfalfa Meal[1]	Dehydrated Alfalfa Meal[2]
Arginine	0.64	0.91	0.77
Histidine	0.27	0.27	0.33
Isoleucine	0.73	0.82	0.81
Leucine	0.91	1.27	1.28
Lysine	0.55	1.00	0.85
Methionine	0.09	0.18	0.27
Phenylalanine	0.55	0.82	0.80
Threonine	0.64	0.73	0.71
Tryptophan	0.09	0.27	0.34
Valine	0.64	0.82	0.88

[1]National Academy of Science, 1972.
[2]National Research Council, 1988.

Alfalfa is characteristically high in calcium (Table 1.3). However, it has only a fair phosphorus content. When grown on phosphorus-deficient soils, it may be very low in phosphorus. Therefore, rations containing high levels of alfalfa require supplemental phosphorus to meet the pigs phosphorus requirement and to narrow the rather wide calcium:phosphorus ratio present in this forage. Alfalfa is a reasonably good source of other minerals such as magnesium, potassium, copper, manganese, iron, chloride and zinc. The selenium content of alfalfa varies, depending on the area in which it is grown.

Alfalfa hay is a good source of most vitamins (Table 1.4) and is an excellent source of vitamins A, E and K. Field-cured alfalfa hay is also a good source of vitamin D. However, due to the fact that it is not exposed to sunlight in the curing process, the vitamin D content of artificially dehydrated alfalfa meal is only one-fourth to one-third as high as that found in sun-cured meal. Good alfalfa hay is also quite rich in riboflavin, pantothenic acid, biotin and niacin. However, the advent of relatively cheap sources of these nutrients has resulted in a reduction in the need for alfalfa in the diet as a source of these nutrients.

Table 1.3. Mineral Content of Alfalfa (% as fed)

	Alfalfa Hay[1]	Sun Cured Alfalfa Meal[1]	Dehydrated Alfalfa Meal[2]
Calcium (%)	1.29	0.87	1.40
Magnesium (%)	0.31	----	0.29
Phosphorus (%)	0.21	0.17	0.23
Potassium (%)	1.99	----	2.38
Sodium (%)	0.15	0.17	0.10
Sulfur (%)	0.29	0.24	0.23
Copper (mg/kg)	18.5	----	10.0
Zinc (mg/kg)	----	31.8	19.0
Manganese (mg/kg)	56.5	----	31.0
Selenium (mg/kg)	----	----	0.33

[1]National Academy of Science, 1972.
[2]National Research Council, 1988.

Table 1.4. Vitamin Content of Alfalfa (as fed)

	Alfalfa Hay[1]	Sun Cured Alfalfa Meal[1]	Dehydrated Alfalfa Meal[2]
Vitamin A (IU/g)	109	64	---
Vitamin D (IU/g)	1.5	---	---
Vitamin E (mg/kg)	102	386	111
Biotin (mg/kg)	0.16	0.32	0.33
Folic Acid (mg/kg)	3.10	5.72	4.40
Choline (mg/kg)	----	1021	1369
Niacin (mg/kg)	----	34	37
Pantothenic Acid (mg/kg)	----	28	30
Riboflavin (mg/kg)	----	10	13
Thiamine (mg/kg)	----	2.6	3.4

[1]National Academy of Science, 1972.
[2]National Research Council, 1988.

UNDESIRABLE CONSTITUENTS IN ALFALFA

Saponins are bitter tasting compounds present in alfalfa (Leamaster and Cheeke, 1979) which have been shown to impair growth rate in chicks and possibly in pigs. The mechanisms by which saponins cause growth depression have not been determined. However, Cheeke (1976) suggested several possibilities including a depressing effect on feed intake or an inhibitory effect on digestive enzymes. In addition, it was suggested that saponins may complex with nutrients to make them unavailable or that saponins may inhibit cellular metabolism (Cheeke, 1976).

It is possible through genetic selection to produce cultivars of alfalfa with a lower saponin content (Pedersen and Wang, 1971). It would appear that cultivars containing lower levels of saponins are more palatable and support higher levels of performance than do traditional alfalfa varieties. Future research, directed towards the development of high-yielding, low-saponin varieties, may allow for higher levels of alfalfa to be incorporated into swine diets.

Alfalfa also contains about 3.25% total tannins (Millic et al., 1972). Tannins are water-soluble polymeric phenolics that depress protein digestibility by binding dietary protein as well as by inhibiting digestive enzymes (Jung and Fahey, 1983; Mcleod, 1974). Tannins also depress feed intake due to astringency (Glick and Joslyn, 1970). In addition, a trypsin inhibitor has been identified in alfalfa (Ramirez and Mitchell, 1960) and there is also evidence that alfalfa contains a photosensitizing agent (Lohrey et al., 1974).

FEEDING ALFALFA TO SWINE

Starter Pigs

Alfalfa should not be used in diets fed to weanling pigs. Its high crude fiber content and low digestible energy level are likely to limit growth and reduce the efficiency of feed utilization when fed to pigs of this weight range. Other alternatives are available and producers would be wise to choose a higher energy feedstuff as the foundation for their starter diets.

Growing Pigs

Alfalfa should also be used sparingly in diets fed to grower pigs. The effects of the addition of 0, 20, 40, or 60% alfalfa meal on the performance of growing-finishing swine are shown in Table 1.5 (Powley et al., 1981). Pigs fed diets containing high levels of alfalfa meal gained significantly slower and with a reduced feed efficiency in comparison with those pigs fed the control diet. The reduction in gain occurring when high levels of dietary alfalfa are fed appears to be the result of insufficient dietary energy. Pigs fed high levels of alfalfa meal cannot consume sufficient feed to meet their energy requirements for maximum growth. Similar results were reported by Kass et al. (1980) and therefore the inclusion of alfalfa meal in the diet of grower pigs is not recommended.

Poor palatability is one factor accounting for the reduction in performance resulting from the inclusion of high levels of alfalfa in the diet of the growing-finishing pigs. Table 1.6 shows the results of a feeding trial in which pigs were given a choice between a standard corn-soybean meal diet and one in which pigs were given a choice between a standard corn-soybean meal diet and one in which 0.5, 1.0, 2.5, 5, 10, 20, or 30% alfalfa meal was added at the expense of corn (Leamaster and Cheeke, 1979). When only

0.5% alfalfa was present, pigs consumed approximately the same amount of each diet. However, at all other levels of inclusion, the pigs showed a distinct preference for the alfalfa free diet.

Table 1.5. Performance of Pigs Fed Alfalfa

	Level of Alfalfa (%)			
	0.0	20.0	40.0	60.0
Daily Gain (g/day)	860	730	630	410
Daily Intake (kg/day)	3.0	3.0	3.2	2.7
Feed Efficiency	3.6	4.1	5.0	6.7
Dressing Percentage	77.9	76.2	75.4	75.2
Backfat Thickness (cm)	3.9	3.5	3.2	2.9

Powley et al., 1981.

Table 1.6. Effect of Dietary Alfalfa on Diet Preference of Swine

Dietary Alfalfa (%)	Control	Alfalfa Diet
0.5	49	51
1.0	63	37
2.5	66	34
5.0	65	35
10.0	74	26
20.0	81	19
30.0	97	3

Leamaster and Cheeke, 1979.

Finishing Pigs

Backfat thickness has been shown to be reduced by feeding high levels of dietary alfalfa (Table 1.5). This may result in improvements in carcass grade. Unfortunately, the economic losses arising from the extended feeding period are unlikely to be offset by these improvements in carcass quality. However, if carcass quality is sufficiently poor it may be beneficial to include 10% alfalfa in the diet of finishing pigs.

Breeding Stock

Alfalfa has the greatest potential for use in diets fed to gestating sows. The use of alfalfa in gestation rations has been studied for over thirty years