NUTRITIVE VALUE OF ALGAE FOR SWINE

H. F. HINTZ · H. HEITMAN, JR.

When added to barley in a ration, algae provided the same protein quality as meat and bone meal for growing or fattening pigs, according to tests conducted at Davis.

THE CULTURE OF ALGAE in waste waters is not only a potential solution to the problem of conservation, but, if the algae can be economically harvested and sold for livestock feed, the cost of treating sewage would be decreased. Protein deficiencies that exist in many areas of the world also could be alleviated. The study reported here on the nutritive value of algae grown on sewage was made by the Department of Animal Husbandry, University of California, Davis, as a result of sanitary engineering research on the Berkeley campus.

Although there is some variation in the percentages of the different types of algae grown on sewage, *Scenedesmus quadricauda* is the most predominant organism, and *Chlorella* is next in abundance. Large mixed batches—fairly typical of algae as it grows on sewage—were used in the nutrition studies.

Three groups of four litter-mate gilts were divided at random in testing four rations so that one gilt from each litter was fed each ration. The four rations in the first trial contained levels of 0, 2.5, 5 and 10% of air-dried algae, respectively. The pigs weighed about 84 lbs at the beginning of experiment. Nine hundred pounds of each ration were mixed and fed individually to the hogs over a 46-day period. The percentage of crude protein in these rations varied from 15 to 16% on an air-dry basis. Algae were added at the expense of the protein components of the rations, as shown in table 1.

TABLE 1—COMPOSITION OF RATIONS USED IN TRIAL 1

Components	Ration 1	Ration 2	Ration 3	Ration 4
	Per cent			
Ground barley	79.5	79.5	79.5	80.5
Alfalfa meal	5	5	5	5
Meat and bone scraps	6	5.5	4	4
Soybean oil meal	4.5	3.5	3	...
Cottonseed oil meal	4.5	3.5	3	...
Algae	..	2.5	5	10
Salt	0.5	0.5	0.5	0.5

One gilt on the 5% algae level scoured badly and was removed from the trial; another on the 2.5% algae ration also scoured slightly. Neither of these two animals was included in the calculations. Weight gains for this trial are shown in table 2. Pelleted feed was readily consumed, and the algae-fed pigs performed as well as controls.

TABLE 2—RELATIONSHIP BETWEEN WEIGHT GAINS AND ALGAE RATIONS IN TRIAL 1

	Ration 1	Ration 2	Ration 3	Ration 4
Percentage algae	0	2.5	5	10
Av. daily feed, lb.	6.54	6.08	6.15	6.48
Av. daily gain, lb.	1.70	1.62	1.60	1.66
Feed per lb. of gain	3.86	3.85	3.85	3.90

A second trial was conducted to compare algae and meat and bone meal as protein supplements. The algae used in this trial were drum dried. Pelleted rations containing 14% crude protein were fed until the pigs weighed approximately 130 pounds; then the protein content was reduced to 12%. Diet composition is shown in table 3. Seven pigs were assigned to each treatment according to size and sex. Three pigs were group-fed, and four pigs were individually fed. The digestibility of the 14% protein rations and a control ration containing no algae was determined with individually fed pigs (using the chromium oxide indicator method).

TABLE 3—COMPOSITION OF RATIONS USED IN TRIAL 2

Components	Control ration	Low algae ration	High algae ration
PERIOD I (14% protein)			
	%	%	%
Barley	88.0	88.0	87.6
Meat and bone meal	4.0	4.0	...
Cottonseed meal	6.0	...	...
Algae	...	6.0	10.0
Dicalcium phosphate	1.0	1.0	1.0
Salt (trace mineral)	0.5	0.5	0.5
Vitamin-mineral mix*	0.5	0.5	0.5

PERIOD II (12% protein)	Low algae	High algae
	%	%
Barley	93.5	93.2
Meat and bone meal	2.0	...
Algae	2.5	4.8
Dicalcium phosphate	1.0	1.0
Salt (trace mineral)	0.5	0.5
Vitamin-mineral mix*	0.5	0.5

* Vitamin mix supplied the following per ton of feed: riboflavin, 2 gm.; niacin, 10 gm.; pantothenic acid, 6 gm.; vitamin B_{12}, 10 mg.; vitamin A, 800,000 IU; vitamin D, 100,000 IU; $ZnCO_3$ 90 gm.

The pigs were weighed weekly and removed from the trial when they weighed at least 196 pounds. The results of a growth trial are summarized in table 4. The pigs on the high algae ration had an average backfat measurement of 1.29 inches and those on low algae had an average of 1.31 inches. There were no significant differences between rations or between the individual or group-fed pigs. Therefore, it appears algae, when added to barley, has at least the same protein quality as meat and bone meal for growing or fattening pigs.

TABLE 4—SUMMARY OF GROWTH IN TRIAL 2

Algae in ration	Av. starting weight	Av. final weight	Av. daily gain	Feed/pound gain
Per cent	lb.	lb.	lb.	lb.
PERIOD I (14% protein)				
6	71.7	124.9	1.52	3.48
10	71.4	135.6	1.60	3.36
PERIOD II (12% protein)				
2.5	124.9	199.3	1.91	3.72
4.8	135.6	200.3	1.97	3.66
PERIODS I AND II COMBINED				
Low algae	71.7	199.3	1.72	3.61
High algae	71.4	200.3	1.77	3.51

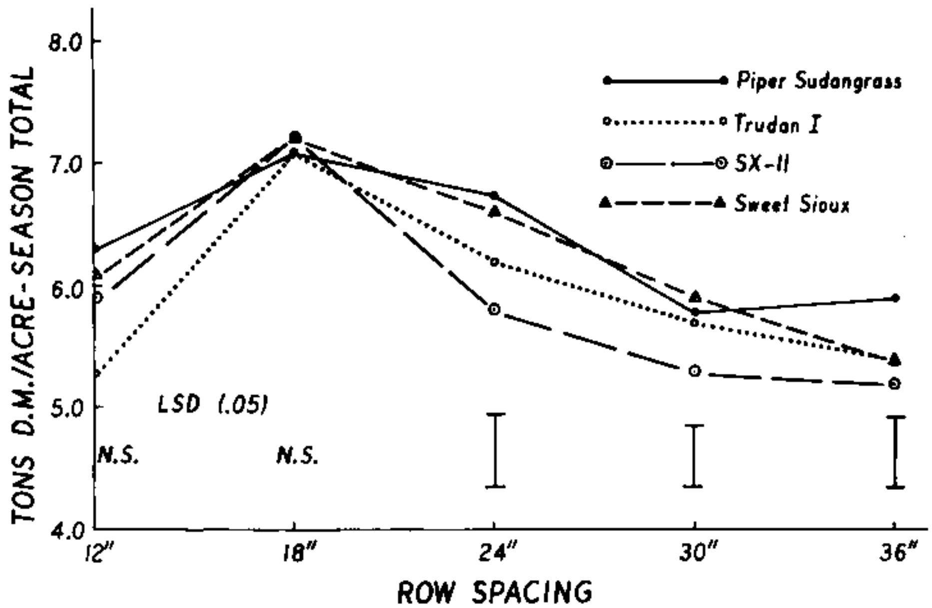
There was a significant decrease in the digestibility of dry matter, protein and crude fiber but there were no differences in the digestibility of the ether extract or the nitrogen-free extract (in the rations containing algae). The digestion coefficients for algae were calculated by difference, and composition and digestibility are shown in table 5. The total digestible nutrients (TDN) content was calculated to be approximately 50%.

TABLE 5—COMPOSITION AND DIGESTIBILITY OF ALGAE

Algae components	Components per cent	Digestion coefficients (per cent)
Crude protein	44	56
Ether extract	6	56
N-free extract	20	84
Crude fiber	8	0
Ash	14	..

In summary, algae contain about the same level of crude protein as other protein supplements, such as cottonseed meal, and the protein quality is similar to that of meat and bone meal when added to a barley ration. However, the protein digestibility is lower than other common protein supplements, and this fact should be considered when balancing rations. The energy content of algae is low because of the decreased digestibility of the dry matter and because of the high ash content. However, only low levels of algae are needed to increase the protein level of the barley ration and would not greatly dilute the energy content of the ration.

H. F. Hintz is Assistant Professor, and H. H. Heitman is Professor and Chairman of the Department of Animal Husbandry, University of California, Davis.



GRAPH 1, Variety response to row width when used as summer irrigated pasture.

Row Width Effects on Pasture Yields of Irrigated Sudangrass and Hybrid Cultivars

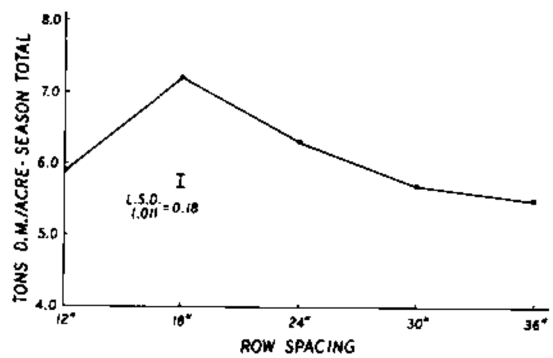
D. C. SUMNER

Establishing an annual irrigated pasture costs about the same as one based on perennial species. Therefore, every management opportunity should be taken to obtain maximum economical yields from the annual type, commensurate with the feed quality desired. One factor often overlooked by annual summer pasture operators that can favorably influence yield, is row spacing. It has been demonstrated many times that sudangrass stands are more productive when drilled than when broadcast. From experiments conducted under nonirrigated conditions in Illinois, it was determined that there was no significant difference in dry matter production of Piper sudangrass from row widths of 4, 8, and 16 inches. These trials were not harvested in the vegetative stage of growth as pasture but in the early bloom stage, nearing maturity.

Trials conducted by the University of California Extension Service in Alameda County in 1959 demonstrated that when Sudan 23 was harvested in the later stages of growth, there was essentially no difference in yield between 6-, 12-, 18-, or 24-inch rows. In 1960, using the same row spacings but harvesting at a much earlier stage of growth, Sudan 23 was most productive at the 18-inch row spacing.

During 1964, tests were conducted at the University of California at Davis to determine the effect row spacing may have upon pasture yields. A split-plot experimental design with five replications was used. Row spacings of 12, 18, 24, 30, and 36 inches were used as the main plots and four varieties were used as the subplots. The response to these row-spacings of Piper sudangrass, Trudan I (a sudangrass hybrid), SX-11 (a grain sorghum hybrid × sudangrass), and Sweet Sioux (a sorgo hybrid × sudangrass) were compared. The plots were seeded May 13 with seeding rates adjusted to give approximately 15 viable seeds per foot of row for all varieties. Fifty pounds of nitrogen was applied preplant and after each harvest, at which times the plots were irrigated. Four harvests were made during the season, based upon the growth of Piper sudangrass, and ranged nearly 30 inches in height—except for one harvest date when Piper reached nearly 45 inches before harvest. These stand heights are within the normal range for use as pasture.

The effects which row spacing had upon dry matter yield of irrigated sudangrass, and the hybrid types tested, when used as pasture, are illustrated in graph 1. The results suggest that production from sudangrass pastures can be increased by more than 20% when row widths are changed from 12 to 18 inches. Row widths greater than 18 inches resulted in lowered yields. Graph 2 illustrates the response to row spacing of different varieties. It appears that 18-inch rows of varieties tested are more conducive to producing maximum pasture yields than the other row spacings tested. There is evidence to support a contention that as sudangrass and the hybrid cultivars approach the late greenchop, hay, or silage stages of development, row spacing may have little or no effect upon dry matter yield. However, when weeds are a problem it must not be overlooked that closer row spacings, or a broadcast seeding, may be more desirable.



GRAPH 2, Yield response to row widths. Mean of the seasonal yields of Piper, Trudan I, SX-11 and Sweet Sioux when used as summer irrigated pasture.

D. C. Sumner is Specialist in the Experiment Station, Department of Agronomy, University of California, Davis. Research Project 2024.