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VALUE OF A WHEAT PROTEIN HYDROLYSATE AS A PROTEIN SUPPLEMENT FOR FATTENING CATTLE[1]

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Mono-sodium glutamate, a salt of one of the amino acids, is used to enhance human food flavors. One source of this amino acid is from hydrolysates of wheat protein. By this process, wheat protein is split into its component parts—amino acids—thus permitting the extraction of the glutamic acid. The remainder of the hydrolysate contains the other amino acids and nitrogen compounds of wheat protein as a by-product of this process. This by-product has much the same nitrogen or crude protein content as soybean oil meal and is currently not being utilized. The product has been given a code number, MC-11, and will be so referred to in this publication.

The objective of these experiments was to determine whether or not this by-product could be used as a protein supplement for beef cattle. Three types of experiments have been conducted. (1) Artificial rumen studies to determine whether rumen microorganisms are able to utilize the nitrogen in MC-11; (2) metabolism experiments with sheep to determine the apparent digestibility of rations containing MC-11; (3) cattle feeding experiments to study the rate and efficiency of gain of fattening steers fed MC-11 as the protein supplement.

The MC-11 used in these experiments was a dark brown liquid with an odor and taste very similar to soya sauce. Some analyses of this product are presented in Table 1.

[1]The research reported herein was supported in part by a grant from The International Minerals and Chemical Corporation, Chicago, Illinois. The by-product material used in these experiments was obtained from their plant, located near Toledo, Ohio.

TABLE 1.—Analysis of MC–11*

	Percent
Total solids	55
Amino solids	40
Ammonia nitrogen	2.15
Total nitrogen	7.42
Crude protein	46
Salt	10 –12
Amino acids	
Arginine	1.9
Aspartic acid	1.1
Cystine	0.24
Glutamic acid	3.2†
Histidine	0.23
Isoleucine	1.6
Leucine	1.0
Lysine	0.79
Methionine	0.31
Phenylalanine	2.4
Threonine	0.41
Tyrosine	0.49
Valine	2.4
Proline	4.5
pH	4.8 – 5.0

*The data in this table were supplied by the International Minerals and Chemical Corporation.

†Before the extraction the level of glutamic acid in the hydrolysate (MC-11) would be 4-6 times this level.

Artificial Rumen Experiment

In this experiment, rumen contents were obtained from a fistulated steer being fed good quality alfalfa hay. The rumen contents were strained through cheesecloth, the liquor was centrifuged through a Sharples supercentrifuge, and the portion of the sediment containing rumen organisms was used to inoculate fermentation flasks. In addition to water the flasks contained cellulose, glucose and all essential minerals. Nitrogen was supplied by the addition of various amounts of MC-11. The flasks were then held in a water bath at body temperature under anaerobic conditions for 30 hours. At the end of this time the contents were analyzed for protein to determine the amount synthesized by the rumen microorganisms from the nitrogen supplied by the MC-11. The results of this experiment are presented in Table 2.

TABLE 2.—Utilization of the Nitrogen of MC–11 by Rumen Microorganisms *In Vitro*

MC-11 additions to the fermentation flasks	Nitrogen added	Ammonia nitrogen available	Protein synthesized
Mg.	Mg.	Mg.	Mg.
None	0	2.7	1.1
75	5.8	4.3	4.0
150	11.6	5.9	5.0
300	23.2	9.1	8.2
451	34.8	12.3	9.7
751	58.0	18.8	12.4
1277	98.7	30.2	13.8

The results of this artificial rumen experiment show that the nitrogen of MC-11 is well utilized by rumen microorganisms. The amount of protein synthesized from MC-11 in this experiment was very similar to that synthesized from urea in other experiments.

Digestibility Experiments

The digestibility of the crude protein present in MC-11 was determined using 120 to 150 lb. wethers. The results of these digestion trials are summarized in Table 3.

The wethers were first fed the poor hay-corn-mineral basal ration during a 7 day adjustment period, followed by a 7 day trial during which time they were kept in individual crates where total collections of the excreta were obtained for subsequent chemical analyses. The low protein basal ration contained 6.6 percent crude protein. The various protein supplements used in this study were added to increase the protein level of the ration to about 11.0 percent. Since digestibility data for a feed supplement such as MC-11 can best be evaluated when compared to other protein concentrates of known feeding value, data on the apparent digestibility of the same basal ration supplemented with either soybean oil meal or urea were also obtained.

The apparent digestibility of the dry matter and the cellulose portion of the crude fiber was similar for each ration, **i. e.** the basal ration vs. the basal ration plus the various protein concentrates. Increasing the protein content of the ration had a marked effect on the apparent digestibility of the crude protein of the ration. Only 38.3% of the protein of the basal ration was used but when soybean meal was added the digestion level was 66.8% and for urea, 65.5%. The level for MC-11

TABLE 3.—The Apparent Digestibility of Rations Supplemented with either MC–11, Soybean Oil Meal or Urea by Wethers *, †

	Rations			
	Basal	Basal + soybean oil meal	Basal + urea	Basal + MC-11
Average feed intake per wether, 7 days, lb.:				
Mature timothy hay	9.93	9.80	10.37	11.23
Corn	2.97	1.65	3.02	2.97
Mineral mixture	0.31	0.31	0.31	0.31
Soybean oil meal		1.37		
Urea			0.212	
MC-11				0.84
Total dry matter intake	13.21	13.13	13.91	15.34
Total nitrogen intake	0.140	0.254	0.254	0.254
Crude protein, percent	6.62	12.08	11.40	10.36
Apparent digestibility, percent:				
Dry matter	56.4	60.5	55.4	58.8
Crude protein	38.3	66.8	65.5	60.6
Cellulose‡	54.9	58.3	56.0	56.8

*The animals were essentially in nitrogen balance during these digestion trials, based on fecal and urinary nitrogen excretion data.

†The same 4 wethers were fed each ration.

‡As determined by the Crampton-Maynard method for cellulose.

was 60.6%—slightly less than for the other two supplements but still decidedly more than for the basal ration without the protein concentrate. A possible explanation for the apparent lower digestibility of the MC-11 ration is that the animals consumed about 10% more of the poor hay when fed this supplement. Although animals consumed about the same amount of protein from both rations, a greater proportion of the protein came from the poor hay in the MC-11 ration than in the soybean oil meal supplemented ration. This would have the over-all effect of depressing the apparent total protein digestion, since the poor hay protein is much less digestible than the protein supplied by soybean oil meal.

These results would indicate that the nitrogen (expressed as crude protein) in MC-11 is well utilized by wethers. Presumably, the rumen microflora metabolize or utilize nitrogen supplied in the form of amino acids, thereby aiding the ruminant animal in the utilization of MC-11 much as with urea which is a synthetic non-protein nitrogen compound

of a different type. Besides microbial utilization of the nitrogen supplied by this hydrolysate, it would be possible for the free amino acids to be absorbed from the gastro-intestinal tract directly without first being converted into bacterial protein.

That MC-11 nitrogen is utilized by the rumen microflora is further indicated by the results of the artificial rumen experiment previously discussed.

Cattle Feeding Experiments

Two experiments were conducted to determine the value of MC-11 as a protein supplement for fattening cattle fed under feed lot conditions. Lots of seven steers each were used in these experiments. They were fed in a barn with access to small, paved outside lots and were hand full fed ground ear corn. Good quality mixed hay was fed to all lots and they were allowed free access to salt and to a mineral mixture of two parts steamed bone meal, two parts ground limestone and one part salt.

In the first experiment the protein supplements were poured over the ground ear corn at feeding time. When fed in this way and at the rate of 1.5 pounds (MC-11) per head per day, the steers appeared to object to the odor or taste of MC-11. They were fed this amount of MC-11 for 98 days, after which it was reduced to 0.75 pound and fed with 1.0 pound of molasses per head daily. The results obtained with these steers and those fed soybean oil meal as the protein supplement are presented in Table 4.

When fed at the rate of 1.5 pounds per head daily the steers fed MC-11 gained much slower than those fed soybean oil meal. After the amount of supplement fed was reduced and molasses was included in the ration the steers fed MC-11 gained somewhat faster than those fed soybean oil meal. The rapid gain of the MC-11 fed steers during the second period was undoubtedly influenced by the slow gain they had made during the first period. For the entire experiment, periods I and II combined, the cattle fed MC-11 did not gain quite as fast, nor grade or yield carcasses quite as high as those fed soybean oil meal.

In the second cattle feeding experiment, the ground ear corn and protein supplement were thoroughly mixed in a small spiral mixer at each feeding. When fed in this manner there was no palatability problem with the MC-11. In fact, the cattle fed this by-product ate slightly more of this mixed feed than those fed soybean oil meal. The rations fed and results obtained in this experiment are given in Table 5.

TABLE 4.—Value of MC–11, a Wheat Protein Hydrolysate, as a Protein Supplement for Fattening Cattle

Experiment I 1953-1954	Period I Nov. 19 to Feb. 25		Period II Feb. 25 to July 15	
	1.5 lb. MC-11	1.5 lb. soybean oil meal	0.75 lb. MC-11 + molasses	0.75 lb. soybean oil meal + molasses
Lot	3	4	3	8
Number in lot	7	7	7	7
Average initial weight, lb.	462	459	580	660
Average final weight, lb.	586	646	951	988
Days on feed	98	98	140	140
Average daily gain, lb.	1.26	1.91	2.61	2.35
Average daily ration:				
Corn and cob meal, lb.	8.0	8.0	16.1	16.7
MC-11, lb.	1.5		0.75	
Soybean oil meal, lb.		1.5		0.75
Molasses, lb.			1.0	1.0
Mixed hay, lb.	3.1	3.1	2.0	2.0
Salt, oz.	0.9	1.2	1.5	0.8
Minerals, oz.	1.2	1.6	1.0	0.8
Feed per cwt. gain, lb.:				
Corn and cob meal	634	421	616	713
MC-11	118		29	
Soybean oil meal		78		32
Molasses			38	43
Mixed hay	247	163	77	85
Salt	5	6	4	3
Minerals	6	9	2	2
Feed cost per cwt. gain	$23.17	$15.46	$17.65	$20.25

	Periods I and II Nov. 19 to July 15		
Lot	3	4	8
Average daily gain, lb.	2.05	2.12	2.19
Feed cost per cwt. gain	$19.17	$18.42	$18.58
Dressing percentage	59.7	61.8	61.5
Carcass grade*	1.10	0.90	0.77
Live value per cwt. †	$23.12	$23.99	$23.76

*Carcass grade factor: Prime = 0, 0.4, 0.7; Choice, 1.0, 1.4, 1.7.

†Calculated from carcass grade, weight and prices as follows: Prime $39.00 and choice, $38.50.

Steers fed either MC-11 or soybean oil meal gained significantly faster than those fed no protein supplement. Average daily gains were much the same whether 0.75 lb. of MC-11 or soybean oil meal, with or without molasses, or 1.5 pounds of soybean oil meal were fed. The steers fed MC-11 required slightly more corn per unit of gain than those fed an equal weight of soybean oil meal. Without molasses, the steers

TABLE 5.—Value of MC–11, a Wheat Protein Hydrolysate, as a Protein Supplement for Fattening Cattle

Experiment II March 1 to July 5, 1955	No supplement	0.75 lb. MC-11	0.75 lb. MC-11 + molasses	0.75 lb. soybean oil meal	0.75 lb. soybean oil meal + molasses	1.5 lb. soybean oil meal
Number in lot	7	7	7	7	7	7
Average initial wt., lb.	722	726	722	724	721	720
Average final wt., lb.	942	982	985	984	983	985
Average daily gain, lb.	1.75	2.03	2.09	2.06	2.08	2.10
Average daily ration, lb.:						
Corn and cob meal	15.5	16.2	15.9	15.1	15.4	15.5
MC-11		0.75	0.75			
Soybean oil meal				0.75	0.75	1.5
Molasses			1.0		1.0	
Mixed hay	2.3	2.2	2.2	2.2	2.2	2.2
Salt (oz.)	0.5	1.4	1.2	1.3	0.6	0.5
Minerals (oz.)	0.6	0.9	0.1	0.6	0.4	0.7
Feed per cwt. gain, lb.:						
Corn and cob meal	886	800	760	731	740	736
MC-11		37	36			
Soybean oil meal				36	36	71
Molasses			48		48	
Mixed hay	129	111	108	109	108	107
Salt	2.0	1.0	0.5	1.0	2.0	1.5
Minerals	2.0	2.0	0.2	2.0	1.0	2.0
Feed cost per cwt. of gain	$19.73	$19.35	$19.80	$17.87	$19.45	$19.43
Dressing percentage	60.3	61.8	61.2	62.2	62.9	62.3
Carcass grade*	1.61	1.46	1.74	1.53	1.51	1.46
Live value per cwt. †	$23.02	$23.59	$22.92	$23.78	$23.96	$23.97

*Carcass grade factor: Prime = 0, 0.4, 0.7; Choice = 1.0, 1.4, 1.7; Good = 2.0, 2.4, 2.7.

†Calculated from carcass grade, weight and prices as follows: Prime, $39.00; choice, $38.50; good, $36.00.

fed MC-11 required 9 percent more corn and with molasses, 3 percent more corn per hundred weight of gain. This difference could be partially explained by the higher dry matter and energy content of soybean oil meal.

No market price was established for MC-11. Hence, in these cattle feeding experiments the feed costs were calculated by using the same price for MC-11 as that paid for soybean oil meal.

Conclusions

Artificial rumen experiments, digestibility experiments with wether lambs and feeding experiments with fattening steers indicate that MC-11 is a satisfactory protein supplement for ruminants. Rumen microorganisms in an artificial rumen utilized MC-11 nitrogen for the synthesis of bacterial protein. Digestibility experiments have shown that rations containing MC-11 were utilized with much the same efficiency as those containing soybean oil meal or urea. When MC-11 was poured over ground ear corn in the feed bunk it was not palatable to fattening steers. However, when the MC-11 was well mixed with the corn it was consumed in fully as large amounts as a mixture of corn and soybean oil meal. When fed in this manner, the crude protein in MC-11 appeared fully equal to that in soybean oil meal. Considering the slightly larger amount of corn required per unit of gain when MC-11 was the protein supplement, the over-all feeding value of this by-product was approximately 95 percent that of soybean oil meal.