UTILIZATION OF LIQUID SUPPLEMENTS WITH RYEGRASS STRAW

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Liquid protein supplements are palatable, readily accepted by livestock and can be self-fed. These characteristics, coupled with the need to provide supplemental protein to low quality forages to improve their utilization, have increased the use of liquid supplements by the United States cattle industry. Estimated sales in the United States in 1978 were 2.8 million tons.

Liquid supplements using urea as the only source of supplemental crude protein (CP) have shown negative responses (Phillips and Vavra, 1979) or no improvement in forage utilization (Hennessy et al., 1978) when fed in combination with low quality forages. The incorporation of true protein sources such as fish solubles and alfalfa meal into liquid supplements has improved gains (Huber, 1972; Velloso et al., 1971).

The objectives of these studies were to evaluate the effect of incorporating various preformed proteins--cottonseed meal, (CSM), single cell protein (SCP), feather meal (FM), liquefied fish (LF)--into liquid supplements fed in combination with chopped ryegrass straw and monitor the performance in the feedlot.

MATERIALS AND METHODS

Trial I

In this trial, we evaluated the effect of incorporating 10 percent of the total crude protein (CP) of a 30 percent liquid supplement from either CSM or SCP which was harvested from a kraft pulp mill and sonically dehydrated. Both supplements were fed in combination with chopped ryegrass straw. These supplemental sources of preformed protein were ground in a Wiley Mill equipped with a 1 mm screen before being incorporated into the liquid supplements. The two liquid supplements were compared with a liquid supplement that had urea as the only source of supplemental CP. Straw and liquid supplements were fed free choice. The liquid supplements were dispensed from a 55-gallon drum equipped with a lick wheel. The formulation of the liquid supplements is in Table 1.

Liquid supplements were prepared in a recirculating mixer equipped with a 5 horsepower centrifugal pump. The urea was dissolved initally in an equal amount of water before mixing the remaining ingredients. The ingredients were circulated until all were dissolved or suspended.

Animals were randomly allotted to groups of five animals each with an average initial weight of 645 pounds. Group liquid supplement and straw consumption and individual average daily gains (ADG) were determined. Water and a salt mixture (50 percent trace mineralized salt + 50 percent bone meal) were available free choice. Animals were maintained on this feeding regime for 59 days.

Trial II

Two 30 percent liquid supplements containing preformed protein (FM, SCP) were compared to a 100 percent urea based supplement when fed in combination with ryegrass straw under drylot conditions. Animal performance was monitored in the liquid supplement feeding phase and subsequent feedlot phase.

Initially, 15 beef steers were randomly allotted to three groups of five animals each. Average initial weight was 680 pounds. Two of the liquid supplements had 10 percent of their total CP replaced with either FM or SCP derived from a kraft pulp mill dewatered with a polyacrylamide-formaldehyde mixture before being sonically dehydrated. A Wiley Mill equipped with a 1 mm screen was used to grind the SCP before incorporating it into the liquid supplement. The commercial feather meal was incorporated directly into the liquid supplement without grinding. The compositions of the liquid supplements are listed in Table 1. Steers were allowed free access to the liquid supplements and straw during the 84-day feeding period. They had free access to water and a salt mixture (50 percent trace mineralized salt + 50 percent bone meal). Performance criteria were ADG, liquid supplement consumption, and straw consumption. After the liquid supplement feeding phase of the trial was completed, the animals were placed on a backgrounding ration for six days before the feedlot portion of the trial began. The steers were randomly reallotted to three groups of five animals each for the feedlot portion of the trial. In the feedlot phase, three supplemental sources of protein--CSM, SCP, and FM--were evaluated. Rations were formulated to contain 8.5 percent digestible CP on an as-fed basis using CP digestibility coefficients of 81 percent, 65.5 percent, and 81 percent, respectively, for CSM, SCP, and FM. Compositions of the feedlot rations are listed in Table 2. Steers were weighed at weekly intervals. The experiment was terminated for each steer when it reached 10 mm of backfat measured by an ultrasonic device. Performance criteria were ADG, feed consumption, feed conversion, and carcass data.

Trial III

This 120-day trial was completed in April 1980, and evaluated two molasses based liquid supplements with the following basic formulation (Table 3): 1) urea providing all supplementary CP; 2) 10 percent of the total CP provided by liquefied fish. Each of these liquid supplements was fed to three groups of five beef steers. The trial was divided into two phases. In the first 60-day period, the liquid supplements were formulated to contain 20 percent CP. During the second 60-day period, the CP level of the liquid supplement was increased to 30 percent CP. The liquid supplements were fed *ad libitum* via a lick tank. Steers had free access to chopped ryegrass straw, water, and a mineral mix (50 percent trace mineralized salt + 50 percent bone meal) during the experimental period. The average initial weight of the animals was 490.3 pounds. Average daily gains, liquid supplement, and straw consumption were monitored. The objective of the trial was to determine the effect that incorporating the liquefied fish and crude protein level (20 and 30 percent) would have on ADG, liquid supplement, and straw consumption.

Data were analyzed statistically by use of one-way analysis of variance procedure as outlined by Steel and Torrie (1960) and means were compared using the Newman Kuel test for significance.

RESULTS AND DISCUSSION

Trial I.

The ADG, straw, and liquid supplement consumption was (pounds): .46, 9.7, 1.37; .88, 8.8, 2.18; .33, 6.80, .62, expressed on a dry matter basis, respectively, for the urea, SCP, and CSM groups. The LS with SCP resulted in greater gain ($P<.10$) than did the other protein sources. Average daily dry matter (DM) intakes for liquid supplement + ryegrass straw were (pounds): 11.0, 11.0, and 7.4, respectively, for urea, SCP, and CSM groups. The ratios of straw intake to liquid supplement consumption (DM basis) were 7.1, 4 and 11, respectively, for urea, SCP, and CSM groups. This suggests that the source of supplemental preformed protein has an effect on consumption of the liquid supplements since other components of the liquid remained constant. The lower intake of the CSM groups would explain the reduction in performance, but their performance was higher than expected, based on consumption data. The SCP groups consumed approximately the same amount of dry matter as did the urea groups, but their ADG was almost twice that of the urea group. This suggests that the incorporation of preformed protein in liquid supplements does improve performance, which would agree with the work of Jones et al. (1976). This effect could be related to the quality and amount of protein reaching the lower digestive tract or to a more gradual metabolism in the rumen.

A problem noted with SCP and CSM liquid supplements was the inability to maintain them in suspension. This might have accounted in part for differences observed in performance among the liquid supplements. Based on previous *in vitro* solubility work (Kellems and Church, 1979), the SCP seems to be less soluble under simulated rumen conditions than CSM, suggesting that more is bypassing rumen degradation. During the initial 10 days on trial, all groups lost weight, then it appeared that they became adapted to the liquid supplements and started to gain and continued to gain during the remainder of the trial.

Trial II.

The ADG for the 88-day, liquid supplement feeding period were (pounds): 1.25, 1.34, and 1.58, respectively, for the urea, SCP, and FM groups. These ADGs were not significantly different, but a trend for an improvement in performance was observed for the liquid supplements containing preformed protein. The FM showed the greatest improvement in performance.

The average individual daily consumption of dry matter from the liquid supplement, straw, and liquid supplement + straw were (pounds): 1.94, 11.8, 13.8; 1.36, 12.7, 14.1; 2.5, 11.97, 14.5, respectively, for urea, SCP, and FM groups. The ratios of dry matter intake from straw/liquid supplement were 6.1, 9.3, 3.7, respectively, for urea, SCP, and FM groups. These differences in relative consumption of straw and liquid supplements are most likely related to preference or to an effect that the liquid supplements are having on nutrient utilization *in vivo*. The relative intake of preformed protein that is bypassing rumen degradation possibly could account for differences in performance observed. Whatever the reason for the differences, there was a pronounced effect on the relative amounts of liquid supplement and straw consumed among the three groups.

Steers were placed on a common ration for six days before the initiation of the feedlot trial; during this time they lost an average of 38.7 pounds per head.

Feedlot performance data are summarized in Table 4. The ADG in the feedlot were (pounds): 3.92, 4.64, 4.58, respectively, for CSM, FM, and SCP groups. The FM and SCP groups gained faster ($P \leq .10$) than the CSM groups. These results would suggest that the digestible CP values for FM (81 percent) and SCP (65.6 percent) are underestimating their utilization in finishing rations. The general condition of the steers changed rapidly, with the average days to reach 10 mm backfat being 88, 82.5, 81.2, respectively, for CSM, FM, and SCP groups.

Trial III

The ADG, straw, and liquid supplement consumption (DM basis) for the 20 percent CP feeding phase were (pounds): .39, 3.18, 7.11, .51, 3.99, 6.82, respectively, for the urea and liquefied fish supplements. The ADG for the liquefied fish groups tended to be higher compared to the urea groups. The average daily total consumption of dry matter from straw and liquid supplement was 10.3 and 10.8, respectively, for urea and liquefied fish supplemented groups. Dry matter intake expressed as a percent of body weight were; 2.03 percent and 2.07 percent, respectively, for urea and liquefied fish groups. The ratio of straw to liquid supplement intake (DM basis) were 2.2 and 1.9, respectively, for the urea and liquefied fish groups.

During the second phase of this trial, when the CP levels were increased to 30 percent, the ADG, liquid supplement, and straw consumptions (expressed on a dry matter basis) were (pounds): .51, 1.51, 7.13; .81, 2.0, 7.61, respectively, for the urea and liquefied fish groups. The average daily dry matter expressed as a percentage of body weight were 1.61 percent and 1.68 percent, respectively, for the urea and liquefied fish groups. The ratio of straw to liquid supplement intake (DM basis) were 4.79 and 4.22, respectively, for the urea and liquefied fish groups. When the CP level of the liquid supplement was increased, the consumption of liquid supplement was reduced and the straw intake increased. These results would suggest that the 20 percent level was less effective in maximizing the utilization of ryegrass straw compared to the 30 percent level. The incorporation of liquefied fish into liquid supplements increased the consumption of the liquid supplement but did not decrease consumption of straw.

Results from these three trials indicate liquid supplements fed in combination with ryegrass straw can be used to maximize the use of low quality forages and crops residues in producing beef in Oregon.

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Table I. Liquid supplement composition, Trials I and II

	Liquid supplement %, as fed			
		Trial II		
	Trial I			
Ingredients	Cottonseed meal	Single cell protein	Urea	Feather meal
Molasses, cane	71.5	70.6	76.35	74.9
Cottonseed meal	7.3			
Single cell protein[1]		7.9		
Feather meal				3.9
Urea	8.6	8.75	9.8	8.6
Water	8.6	8.75	9.8	8.6
Sulfur	.4	.4	.45	.4
Phosphoric acid, 75%	1.0	1.0	1.0	1.0
Monosodium phosphate	1.0	1.0	1.0	1.0
Limestone	1.5	1.5	1.5	1.5
Vitamin A[2]				
Kelflo[3]	1.	.1	.1	.1
Analysis, as fed basis				
Dry matter	72.3	72.5	70.7	72.2
Crude protein	29.1	29.9	29.5	29.6

[1] Derived from secondary clarifiers of kraft pulp mill dewatered with polyacrylamide-formaldehyde mixture and sonically dried.
[2] 3300 IU/kg.
[3] Suspending aid produced by Kelco, Division of Merck & Co., Inc.

Table 2. Composition of feedlot rations

Ingredient	NRC reference no.	Ration %, as fed: Cottonseed meal	Single cell protein	Feather meal
Alfalfa, chopped	1-00-063	2.6	2.6	2.6
Straw, ryegrass	1-04-059	20	20	20
Molasses, cane	4-04-696	7.5	7.5	7.5
Corn, rolled		32.6	32	33.5
Barley, rolled	4-07-939	32.6	32	33.5
Cottonseed meal	5-01-621	3.1	--	--
Feather meal	5-03-795	--	--	1.32
Single cell protein		--	4.34	--
Urea		.78	.78	.78
Limestone		.6	.6	.6
TM salt		.05	.05	.05
Vitamin A premix[2]				
Ananlsis, as fed				
Digestible crude protein		8.5	8.5	8.5
Crude protein		12.1	11.6	11.9

[1] Single cell protein derived from kraft pulp mill dewatered with polyacrylamide-formaldehyde mixture and sonically dehydrated.
[2] 4,400 IU/kg of feed.

Table 3. Liquid supplement composition, Trial III

	Liquid supplement %, as fed[1]			
	Liquefied fish		Urea	
Ingredients	20% CP	30% CP	20% CP	30% CP
Molasses, cane	78	66.4	85	75.4
Urea	5.3	8.6	6	9.8
Liquefied fish	13.3	20.0	----	----
Water	----	----	6	9.8
Sulfur	.18	0.4	.18	.4
Phosphoric acid, 75%	1.0	1.0	1.0	1.0
Monosodium phosphate	2.0	2.0	2.0	2.0
Limestone	----	1.5	----	1.5
Vitamin A[2]	----	----	----	----
Kelflo[3]	0.1	0.1	0.1	0.1
Analysis, as fed basis				
TDN (computed), %	57.0	50.6	58.0	51.5
Dry matter, %	70.6	68.1	73	71.4
Crude protein, %	19.7	30.5	19.9	30.8
Ca (computed), %	.70	1.13	.75	1.2
P (computed), %	.78	.79	.75	.75

[1] Liquefied fish supplied 10% of total crude protein.
[2] Formulated to contain 1500 IU/lb.
[3] Suspending aid produced by Kelco, Division of Merck & Co., Inc.

Table 4. Feedlot performance of steers fed cottonseed meal, single cell protein and feather meal supplemented rations

	Cottonseed meal	Single cell protein	Feather meal
Initial wt, lbs	755	761	761
Final wt, lbs[a,b]	1100	1134	1165
Days of feed			
Mean	88	81.2	82.6
Range	77-98	77-84	77-91
Gain, lbs			
ADG	3.92	4.6	4.64
ADG (range)	3.37-4.22	4.3-4.95	4.2-5.1
Feed consumption, lbs[c]			
Av. daily	26.4	30.8	28.7
Feed conversion lbs[c]			
lbs feed/lbs gain	6.75	6.72	6.18

[a]Calculated from carcass weight divided by .58.
[b]Cattle slaughtered when backfat measured .4 inches as determined with a sonic probe.
[c]Dry matter basis.

Table 5. Carcass characteristics of steers fed cottonseed meal, feather meal or single cell protein rations

	Treatments		
Variable	Cottonseed meal	Feather meal	Single cell protein
Maturity[a]	A-	A-	A-
Kidney fat, %	2.7	3.1	3.3
Marbling score[b]	9.4	10.4	11.4
Fat color score[c]	5	5	5
Lean color score[d]	5.6	5.2	5.6
Backfat thickness, cm	1.0	1.2	1.1
Ribeye, sq cm	72.9	72.3	71.6
USDA grade[e]	9.4	10.4	11.4

[a] A- = 13-16 months of age.
[b] Moderate = 18; modest = 15; small = 13; slight = 9; trace = 6.
[c] Dark yellow = 1; white = 6.
[d] Bleached red = 1; very dark = 8.
[e] Standard = 6; good = 9; choice = 12.