with pink whites and large salmon-colored yolks (Figure 3) differs from the average of all the eggs in the weight of migrated protein. A questionable feature was that more lipovitellin (0.29 gram) was found with lipovitellenin in these 10 eggs than in the average of all eggs.

Two distinct changes occurred in the proteins of eggs from hens fed cottonseed oil when the eggs were stored for 6 months at 0° C. A transfer of white proteins except ovomucoid and ovoglobulin from the white into the yolk was accompanied by movement of livetin from yolk to white. If ovomucoid and ovoglobulin were transferred in the same proportion as the other egg white proteins, about 0.03 gram of the two would have migrated to the yolk, and 0.10 gram or nearly half of the livetin would have been transferred from yolk to white. The second change was a partial conversion of the lipovitellin to a protein that behaved like lipovitellenin under the conditions of filter paper electrophoresis used.

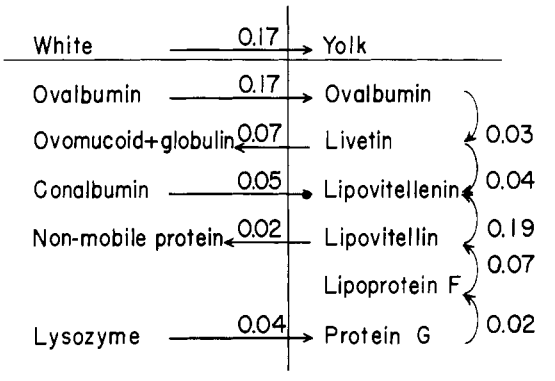

Figure 2. Migration of egg proteins between white and yolk of eggs from hens fed cottonseed oil

Average values for all eggs used as calculated in Tables IV and V. Protein transferred given in grams

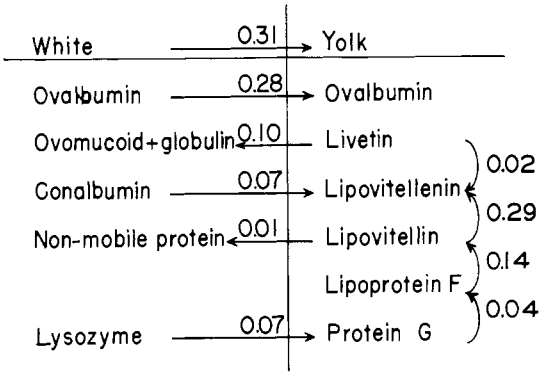

Figure 3. Migration of egg proteins between white and yolk of eggs with pink whites

Average values for 10 eggs which developed pink whites and large salman colored yolks during storage as calculated in Tables IV and V were used. Eggs produced by hens fed crude cottonseed oil. Protein transferred given in grams

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ALCOHOL IN FEEDS

Effect of Ethyl Alcohol and Starch on Digestibility of Nutrients and on Nitrogen Retention at Two Levels of Urea Feeding

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This work is based on a study of whether ethyl alcohol is more effective than starch in increasing the utilization of urea nitrogen on high molasses rations for cattle. Nitrogen retention by steers was increased by addition of ethyl alcohol to a mixture of molasses and urea to about the same extent as by an equal number of calories from starch. Both were much greater than on the basal ration without either starch or ethyl alcohol. Better results, however, were obtained with soybean meal and corn. Ethyl alcohol would appear to be an effective supplement to a ration of poor quality, low-protein roughage, liberal molasses and urea, and when corn or other cereal grains are not fed.

FEW controlled experiments on the use of ethyl alcohol in ruminant nutrition have been reported. Thomson (*13*) described the use of pot ale (an alcoholic beverage) in the nutrition of nursing mothers and high-producing dairy cows. In Italy and France surpluses of cheap wine were sometimes fed to farm animals (*10*). Currently ethyl alcohol is added to a liquid cattle feed consisting of molasses, urea, minerals, and vitamins. In trials involving this liquid feed (*5*, *8*), a favorable effect of ethyl alcohol was observed when it was added to a basal diet of corn cobs, molasses, and urea. Richardson, Smith, Koch, and Cox (*11*) in Kansas have studied the value of ethyl alcohol in molasses mixtures for beef cattle. Steers fed a high roughage ration during the winter consumed more feed on a molasses mixture containing ethyl alcohol, but gained less weight than similar steers fed soybean oil meal and sorghum grain. In the fattening period that followed, the steers receiving alcohol gained faster than the controls, but for the total feeding period there was practically no difference. Other steers fed the same molasses mixture without ethyl alcohol gained as rapidly during both the wintering and the fattening periods as those receiving alcohol. Starch or starchy con-

centrates (mainly corn) have been shown to favor nitrogen retention in urea fed ruminants, more than some other carbohydrates such as sugar in molasses (*2*). A comparison of the effects of starch or corn *vs.* ethyl alcohol in such diets seemed to be desirable.

Experimental

An experiment was designed to test the effect of ethyl alcohol on nitrogen retention and on digestibility of rations containing two levels of urea. Starch or corn meal was replaced by an amount of ethyl alcohol equal in energy content. The combustible energy of pure ethyl alcohol is 1.70 times that of starch.

The six diets used in the trial are presented in Table 1. Three diets (1, 2, and 3) supplied 60% of the nitrogen in the form of urea. Among these, diet 1 was a negative control, whereas diets 2 and 3 were supplemented with isocaloric amounts of ethyl alcohol and starch, respectively. In diets 4 and 5 urea supplied 27% of the nitrogen. In diet 5 ethyl alcohol replaced part of the corn meal of diet 4. Diet 6 contained no urea. Soybean oil meal was a protein source in diets 4, 5, and 6. Starch or ethyl alcohol, urea (in diets 1 to 5), and minerals were fed mixed with molasses. Because of the phosphoric acid added, the pH of these mixtures was between 3 and 4. Trace-mineralized salt blocks were at all times available to the animals.

Six Angus-Holstein crossbred steers weighing an average of 210 pounds at the beginning of the trial and 420 pounds at the end, were used. A 6 × 6 Latin square design was employed. The steers were allowed a constant feed intake at the level they would consume without wastage. The length of the preliminary periods was at least 14 days and collection periods lasted 7 days. Aliquots of feces (10%) and of urine (5%) collected over sulfuric acid were taken. Daily fecal samples were kept frozen until analyzed. For analysis each sample was rapidly thawed and slurried with water to about 12% dry matter content. The slurries were weighed and subsamples were blended with 0.1% thymol. Urine was stored at 0° C. Proximate analyses were performed according to AOAC methods (Table II).

Results and Discussion

The average digestion coefficients, nitrogen retention, and biological values are summarized in Table III. Biological values (*9*) were calculated by estimating fecal metabolic nitrogen on the basis of 0.5 gram per 100 grams of dry matter consumed; endogenous urinary nitrogen was estimated by means of Brody's formula: mg. of $N = 146W^{0.72}$, where W is weight of the animal in kilograms (*4*). Of 36 single trials the results of one were lost (diet 4) and nitrogen retention of another (diet 5) was disregarded, because of abnormally high nitrogen excretion in the urine which resulted in a negative nitrogen balance and was clearly due to an error or to a temporary disturbance of the animal. Missing plots were statistically substituted (*12*). Thus, digestion coefficients of diet 4, nitrogen retentions, and biological values of both diets 4 and 5 are based on five observations and one estimated value each.

For calculating digestibility of nitrogen-free extract, the ethyl alcohol in diets 2 and 5 was included in this fraction of the feed. Two digestion coefficients were calculated for nitrogen-free extract when ethyl alcohol was included: one coefficient in the conventional manner, and a second coefficient after correcting for the higher combustible energy of ethyl alcohol (7.12 kcal. per gram) *vs.* starch (4.18 kcal. per gram), by multiplying the ethyl alcohol intake by the ratio of these figures—i.e., 1.70 (Table III). The latter method produces slightly higher digestion coefficients.

Analysis of variance was performed on all the sets of values obtained. Differences between diets were tested by Duncan's multiple range test (*7*) at probability levels of 1, 5, and 10% (Table IV), regardless of the significance level of the F ratios obtained. Diet numbers are used to represent the diet means presented in Table III and are arranged in increasing order of means from left to right. Any two diet means not underscored by one line are different at the indicated level. For nitrogen digestibility the F ratio was not significant at the 10% probability level. Crude fiber digestibility between diets 1 and 3 was different at the 10% level [Duncan test (*7*), not shown in Table IV]. The nitrogen-free extract digesti-

Table I. Ingredients and Crude Protein Content of Experimental Diets

	High Urea			Low Urea		
	Basal	Basal and ethyl alcohol	Basal and starch	Corn	Corn and ethyl alcohol	Soybean Oil Meal and Corn
	Parts					
Grass hay	62.3	62.3	62.3	66.1	66.1	66.1
Molasses	32.5	32.5	32.5	8.6	8.6	8.6
Urea 262	3.13	3.13	3.13	1.36	1.36	
Ethyl alcohol		1.95			2.05	
Starch			3.60			
Soybean oil meal				7.56	7.56	15.12
Corn meal				14.37	10.59	6.05
Minerals[a]	2.1	2.1	2.1	2.1	2.1	2.1
Crude protein content, %	13.9	13.7	13.5	13.8	13.5	13.0

[a] Ground limestone, 44%; phosphoric acid, 56%.

Table II. Average Composition of Feeds Used in the Diets[a]

Feed	Dry Matter, %	Crude Protein, %	Crude Fiber, %	Ether Extract, %	Nitrogen-Free Extract, %	Ash, %
Grass hay	91.2	7.2	29.8	1.9	47.4	4.9
Concentrate portion of[b]						
Diet 4	88.4	23.2	3.6	2.9	55.8	2.9
Diet 5	89.1	25.9	3.8	2.7	53.4	3.3
Diet 6	89.1	37.0	5.1	2.0	40.6	4.4
Molasses	67.0	3.0	..	..	56.2	7.8
Starch	86.4	..	..	..	..	..

[a] Denatured ethyl alcohol used contained 89.1 wt. % ethyl alcohol, 5.0% ethyl acetate, 5.9% water.
[b] Mixture of corn and soybean oil meal.

Table III. Average Apparent Digestion Coefficients, Nitrogen Retention, and Biological Values

	High Urea			Low Urea		
Diet No.	Basal 1	Basal and ethyl alcohol 2	Basal and starch 3	Corn 4	Corn and ethyl alcohol 5	Soybean Oil Meal and Corn 6
Digestion Coefficients						
Nitrogen	70.1	69.7	68.2	68.7	68.6	67.6
Crude fiber	44.8	43.8	42.1	46.7	46.8	50.3
Ether extract	28.5	25.0	24.3	52.6	48.6	46.3
Nitrogen-free extract	73.4	74.1[a] 74.8	74.4	73.3	73.4[a] 74.0	72.4
Nitrogen retention, g. per day	17.9	21.3	20.0	23.2	25.1	25.0
Thomas-Mitchell biological value	45.0	48.6	48.8	54.7	55.3	59.1

[a] For method used see discussion in text.

bility means were based on the corrected value of ethyl alcohol; with uncorrected values the F ratio was not significant at the $P = 10\%$ level.

The fact that diet 1 (high-urea basal) was highest in nitrogen digestibility and lowest in retention and biological value confirms the common finding that nitrogen utilization on molasses-urea diets is poor compared to diets containing starch or cereal grains (*2, 6*). As expected, the digestibility of crude fiber was lower on the high molasses-urea diets (1, 2, and 3) than on the low-molasses diets (4, 5, and 6), in agreement with published data (*2, 3*). Furthermore, it was lowest on the starch-supplemented diet in the high-urea group (diet 3). The substitution of ethyl alcohol for starch or corn meal seems to have had little effect on crude fiber digestibility, though diet 2 (high-urea–ethyl alcohol) is intermediate between the basal and the starch-supplemented diet. The possibility that ethyl alcohol depresses crude fiber digestion less than starch is not excluded. The differences in digestibility of ether extract merely reflect the fact that only the grain in diets 4, 5, and 6 contained significant amounts of fat. The differences in nitrogen-free extract digestibility are slight and also reflect qualitative differences in this fraction.

The examination of the criteria related to nitrogen retention and biological value reveal very nearly the same picture. Although the diets are ranked in slightly different order, significant differences are found only between diets of the high-urea–molasses group on one hand, and the rest of the diets on the other hand. The differences are more significant when biological values are considered. The reason for this becomes obvious when the results of the analysis of variance with respect to animals are considered. While F ratios for nitrogen retention were different at the 1% level for animals and only at the 5% level for diets, for biological values only the F ratio for diets (4.35) was significant, and this at the 1% level, while the F ratio for animals was negligibly small (0.84). Evidently, the differences in nitrogen retention between animals were highly influenced by the differences in thriftiness between them. In biological values these differences were eliminated by using a more complex criterion based on a ratio corrected for both the weight and intake of the animals. Although seldom used at the present time, the coefficient of variation (ratio of the standard error to the mean) of a certain criterion is a measure of its dependability. In this trial the coefficients of variation of the diet means for biological value and nitrogen retention were 6.7 and 16.2%, respectively.

If biological value is used as the most reliable measure of the influences of ethyl alcohol *vs.* starch upon urea utilization, only negligible differences exist.

Table IV. Significance of F Values and Duncan's Multiple Range Test of Diet Means from Table III

Item	Significance of F Ratio, %	P Level of Duncan Test, %	Diet Number: Lowest mean					Highest mean
Digestion coefficients								
Nitrogen	Not sig.	5	6	3	5	4	2	1[a]
		10	6	3	5	4	2	1
Crude fiber	1	1	3	2	1	4	5	6
		5	3	2	1	4	5	6
Ether extract	1	1, 5 or 10	3	2	1	6	5	4
Nitrogen-free extract	5	1	6	4	1	5	3	2
		5	6	4	1	5	3	2
Nitrogen retention	5	1	1	3	2	4	6	5
		5 or 10	1	3	2	4	6	5
Biological value	1	1 or 5	1	2	3	4	5	6
		10	1	2	3	4	5	6

[a] Diet numbers connected by same line do not differ significantly.

As shown in Table IV even at the 10% level, diet 2 (high-urea–ethyl alcohol) was not different from diet 3 (high-urea–starch) and likewise diet 5 (low-urea–ethyl alcohol) was not different from diet 4 (low-urea–corn). Because there was no difference in the amount of nitrogen stored, one would not expect a difference in the amount of lean meat deposited with alcohol-containing rations as claimed (*8*). Richardson, Smith, Koch, and Cox (*11*) showed that steers fed ethyl alcohol were not different in carcass quality or composition from those fed a balanced ration containing cereal grains and protein supplements. On the other hand the evidence seems clear that the addition of either starch (corn) or ethyl alcohol to a ration of only molasses, urea, and poor roughage might stimulate the formation of protein tissue, although controlled data to support this have not been published.

The steers in this test were fed *ad libitum* and intakes were measured during an initial 8 days in each of the first three periods of the trial. Intakes on the ethyl alcohol diets were about 2% higher than on the other diets. These *ad libitum* feeding periods were then discontinued, because it was felt that 8 days were insufficient to produce sizable differences in intake and to measure possible effects of ethyl alcohol upon appetite and gain in weight (*5, 8*). Average dry matter intakes of the individual steers during the trial were: 3.40, 3.55, 4.45, 4.78, 4.85, and 4.86 kg. per day. Average intakes for periods rose from 3.61 in the first period to 4.84 kg. per day in the sixth period. The use of longer periods in a feeding experiment is necessary to measure the possible effects of ethyl alcohol on palatability and feed consumption.

After this study was completed Bates, Jacobson, Rust, and Seath (*1*) reported that the addition of ethyl alcohol to a mixture of molasses, urea, phosphoric acid, and minerals did not increase the weight gain of dairy heifers.

The effect of ethyl alcohol on nitrogen retention, biological value, and digestibility was measured, when replacing starch added to a diet containing grass-hay, high-molasses, and high-urea, and when replacing part of the corn added to a diet of grass-hay, low-molasses, low-urea, and soybean oil meal. No significant differences were found at the 5% level between ethyl alcohol and starch or between ethyl alcohol and corn when substitution was made on an isocaloric basis, i.e., 1 part of ethyl alcohol for 1.70 parts of starch, dry basis in any of the criteria mentioned. Digestibility of crude fiber was lowest on high-molasses and highest on soybean oil meal and corn. Biological values were nearly identical when ethyl alcohol was compared to starch or to corn meal on the same basal diet. While both ethyl alcohol and starch were useful in improving a diet based on grass-hay, molasses, and urea, a conventional diet containing soybean oil meal as a protein supplement and no urea or ethyl alcohol was superior to all other diets used in this trial. The results support the view that when molasses is cheap enough, a liquid supplement of molasses, urea, and ethyl alcohol or starch might be an economical feed.

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SWEET POTATO NUTRIENTS

Carotene and Ascorbic Acid Content in Improved Sweet Potato Variants

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This investigation shows the levels of carotene and ascorbic acid in present day varieties in relation to those found in the roots of about 240 clones originated as seedlings in the breeding program at the Oklahoma Experiment Station. The results indicate that the full potential of improved vitamin content in the sweet potato is not found in the varieties of this product, now available to consumers. The carotene content might easily be raised from 50 mg. per gram (dry) to 80 mg. Similarly the ascorbic acid content might be increased from the present level of 100 to 150 mg. per 100 grams. Frequency histograms are used to express the carotene and ascorbic acid analyses of the large number of seedling clones.

THE SWEET POTATO is recognized as a good source of carbohydrates, but its value as a source of vitamins is not yet fully appreciated. In recent years the nutritional value of the sweet potato has been greatly improved; at first, by selecting favorable mutations in clones and later, by selecting desirable individuals in seedling populations. Increases in the contents of vitamins A and C have been readily obtained by these methods (*8*).

The carotene and ascorbic acid contents of roots of large numbers of seedling sweet potatoes have been determined as part of a breeding program in progress at the Oklahoma Agricultural Experiment Station. Improvement in nutritional value is considered just as essential in a new variety as increased yields and resistance to disease.

Increasing Carotene Content of Sweet Potatoes

Prior to the initiation of a sweet potato breeding program in the United States, somatic variants showing increased carotene contents were selected within the clones grown as commercial varieties. Some of these varieties originating as sports have been reported by Miller (*1*), Elmer (*7*), and White (*12*). Mutations involving the carotene content of sweet potato roots are of relatively frequent appearance and may be in either direction. Thus, low carotene variants, if not eliminated, result in the deterioration of the desirability of commercial stocks of a sweet potato variety. The principal pigment in sweet potato roots is β-carotene, the precursor of vitamin A, according to Ezell and Wilcox (*2*); the flesh color of the sweet potato root is a good indication of its carotene content.

The examination of clonal varieties originating as carotene mutations reveals that the deviations from the original variety are not uniform. Thus, the mutant strains of the Yellow Jersey variety designated as Rols and Orlis respectively, have about four and ten times the carotene content of the original variety. Carotene mutations at two levels are also found in variants out of Nancy Hall, while the Maryland Golden variety emerged from the Big Stem Jersey with an approximate 10-fold increase in carotene.

After the breeding of sweet potatoes began in the United States, it soon became apparent that some hybrid seedling individuals produced roots higher in carotene than either parent. Thus, by crossing (or by selfing) selected parent sweet potatoes, high carotene individuals were found in the seedling populations. Because of this, many of the new varieties made available by this breeding program—e.g., Goldrush and Allgold—are higher in carotene than the best of the original varieties or those selected as high carotene mutations.

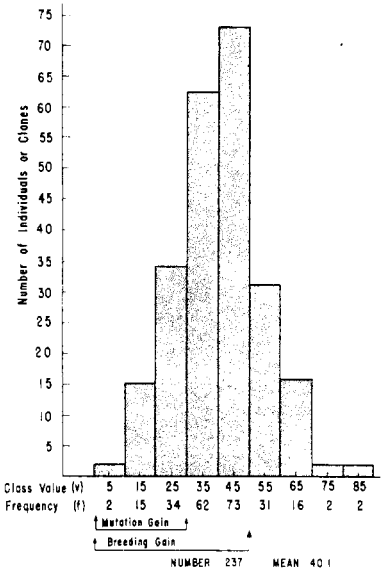

Figure 1. Distribution of 237 sweet potato clones in carotene classes

v. Mid-point indicates class value
f. number in each class, also indicated by column height. Clones were seedlings in the breeding program at the Oklahoma Agricultural Experiment Station. Carotene, milligrams per 100 grams of dry root tissue

[1] Deceased.