A COMPARISON OF THE PALATABILITY AND EFFICIENCY OF PRODUCTION OF VARIOUS SORGHUM GRAINS FOR CHICKS

by

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INTRODUCTION

Palatability is an important factor in selecting feeds for a diet. For profitable egg and meat production, birds must consume large amounts of feed. They do so only if feeds are palatable.

Many inquiries have been received at Kansas State College concerning the palatability and efficiency of different sorghum grains. Corn is not successfully grown in the drier regions of the Southwest, but the sorghum grains are grown extensively and are becoming of economic importance.

Two experiments were designed to test the palatability and efficiency of feeding sorghum grains. Following the suggestions of Clapp (1955) nine varieties were selected for the palatability experiment, and six of the nine varieties were selected for the efficiency experiment. The varieties used are described by Ross and Laude (1955).

REVIEW OF LITERATURE

Few controlled experiments have been conducted on the palatability of feeds for chickens. Several authors have made different observations concerning the effect of color on the palatability of feeds. Newbiggin and Linton (1927) concluded that color has definitely no influence upon selection. Engelman (1940) reported that color has no influence on feed selection.

Anderson and Briggs (1948) fed free-choice feeds which were colored orange, red, blue, and white to day-old New Hampshire chicks. They concluded that the amount of any particular feed

consumed each week varied greatly so that apparently there was no consistent preference for any particular colored feed.

In contrast to the above findings, Gilkeson (1940) reported that chickens like green better than any other color. When five glass drinking fountains were lined up in a row, each one containing a different color of water, laying hens drank all of the green water first, red water next, then brown, and yellow. Despite the fact that hens had been used to drinking clear water, it was the last to be consumed.

Newbiggin and Linton (1927) concluded that whether or not the seed-coat is shiny or dull does not influence selection.

Several authors indicated that another factor involved in the palatability of feeds is the physical condition. Kennard and Nettleton (1927) found that chickens were more favorable to granular or grain-like material than the same material finely ground. Hinds (1937) reported that when feeding both mash and grain forms of corn, barley, and red milo, and a mixture of barley and corn, that grain was more palatable than mash.

Engelmann (1940) found that wheat-form kernels of grain are preferred over rye-form kernels of grain. The wheat-form kernels of grain were preferred even when they were composed of rye mash.

Penquite (1930) concluded that kafir and darso can be substituted for yellow corn in the poultry ration if green feed or some green feed substitute were fed throughout the entire year. Heywang and Morgan (1932) found that Hegari and Yellow Milo could replace corn completely in a chick diet, if the chick diet was not deficient in any other manner.

At the Kansas Station, Payne (1934) discovered that good quality kafir or milo could replace either white or yellow corn pound for pound in a ration for growing chicks or laying hens, provided the diet was adequately supplied with the essential supplements. Hammond (1942) reported Yellow Milo or Hegari was equal in feeding value to white corn in balanced rations for layers. Berry (1952) found this true for laying hens, and the milo used as scratch grain was less expensive.

Smith (1930) concluded that when Hegari was supplemented with the correct amounts of protein, minerals, and vitamin A, the sorghum grain not only promoted growth at an optimum rate, but also supplied the demands of successful reproduction in rats. Every appearance of health and vigor was evidenced.

In South Africa, Serfontein (1937) observed that corn could be replaced entirely by kafir. He noted that feathering was better and chick mortality was lower in the lots receiving kafir.

McClymont and Wilkins (1950) observed that grain sorghum can replace wheat completely in laying rations, but they found that the replacement was unsatisfactory in chick rations. They observed that sorghum grain caused higher mortality and slower growth than wheatmeal.

Ackerson, et al. (1939) found that feeding kalo instead of corn to growing chicks for the first six weeks resulted in no significant difference in growth. Cannibalism seemed to be confined to the lot fed kalo.

Adams (1955) found that when individual grains were used in various combinations, that birds fed a ration composed of portions

of wheat and milo were the most efficient utilizers of feed.

Results reported by Black and Getty (1950) indicated that 25 percent ground sorghum grain in chick mash can safely replace 15 percent corn meal, 5 percent ground barley, and 5 percent ground oats.

Studies conducted by McClymont and Duncan (1952) revealed that apparently there was a toxic substance present in grain sorghums. They reported, contrary to other investigators, that grain sorghums depressed the growth of chickens by 50 percent, if the diet contained from 28 to 63 percent of the grain sorghum. They noted an increase in mortality rate also.

There is evidence to support the fact that sorghum grains can replace other grains as the carbohydrate source in the diets of older birds and to some extent in younger chickens.

Using 10 hens, 6 capons, and 2 roosters, Tuason and Fronda (1924) reported that among the grains, rough rice was most palatable; corn second, and sorghum third. Holst and Newlon (1935) suggested that barley, corn, oats, and wheat were preferred to other grains, such as feterita, kafir, millet, milo, and rice. Among the other grains, they felt that kafir was the most palatable.

Comparing the feeding of rations composed of corn meal, barley, one-half barley and one-half corn, and red milo, Hinds (1937) concluded that there was little observed difference in the palatability of the four grains fed.

In experiments conducted by McClymont and Wilkins (1950), it was observed that the difference in the relative amounts of

mash and grain consumed for the sorghum grain and wheat rations, was highly significant. This indicated either that sorghum grain was less palatable to birds than wheat grain, or possibly that sorghum mash was more palatable than wheat meal mash.

No report was found in the literature using different varieties of sorghum grains as the carbohydrate source for chicken feed. Thayer (1956) reported that several years ago feeding tests using several varieties of grain sorghums were conducted. The Oklahoma workers concluded that the dark seed-coated grain sorghums were not as palatable for poultry. The yellow and white seed-coated sorghums were more palatable for poultry.

Duitsman and Kessler (1955), at the Fort Hays Branch Station found that apparently there was no difference in the gains of the two lots of cattle fed Midland and Martin grain sorghums. In the trial conducted in 1952-53, cattle fed Martin made better gains. The reverse was true the next year.

Ross and Laude (1955) commented that although animals sense a difference among varieties of sorghum grains, with reference to palatability, little difference was encountered as long as the same variety was fed continuously.

Aubel and Swanson (1951) conducted experiments investigating the relative palatability of the new varieties of sorghum grains for livestock feeding. Three pigs were fed individually. Each pig was permitted to eat free-choice from nine varieties of ground sorghum varieties. There was not complete accord in the tastes of the three pigs. The over-all relative palatability of the nine sorghum varieties was in the following order: Westland,

Gurno, Midland x Wonder Club, Midland, Martin, Cody, Cody x Wonder Club, Westland x Cody, and Leoti x Atlas. They noted that varieties high in tannin, low in niacin, and non-waxy were more palatable varieties.

MATERIALS AND METHODS

The research was divided into two experiments. Experiment I was designed to compare the palatability of the various sorghum grains. Experiment II was planned to determine the efficiency of certain varieties of sorghum grains.

The varieties used were those recommended for Kansas. Ross and Laude (1955) recommended the following grain sorghums for Kansas: Coes, Colby, Martin, Midland, Westland, Plainsman, and K44-14. These varieties with exception of the first two were used in the palatability experiments. In addition, Atlas, a recommended forage sorghum was used, and three other grain sorghums were used: K60, Hegari, and Pink Kafir.

The commonly grown grain varieties were described by Ross and Laude (1955). The Midland variety has red seeds, Martin has red-brown seeds, Plainsman has red seeds, Westland has red-yellow seeds, while K44-14 has white seeds.

Other grain sorghums are described as follows: K60 is white-seeded, Hegari has chalky white seeds, and Pink Kafir has pink-white seeds. Atlas, the forage variety, is white-seeded.

In the efficiency experiments, the following varieties were used: Atlas, Hegari, Martin, Midland, Westland, and K44-14. These varieties were used in the palatability experiment with the

following three additions: Pink Kafir, Plainsman, and K60.

Kansas State College Strain White Plymouth Rock chicks were used in all experiments. All chicks were wing banded and weighed at one day of age. The experiments were conducted for nine weeks during which time the chicks were weighed each week. Weekly feed consumption records were maintained. Temperature, waterers, and feeders were adjusted in keeping with the growth of the chicks.

For both experiments, the same diet was used with the variable being the variety of sorghum. The protein content of the diet was adjusted to 20 percent. Analysis of the ingredients used in computing the diets was obtained from the National Research Council Nutrients Requirements For Poultry (1954). The basal formula used is listed in Table 1.

Diets were mixed in the feed building at the College Poultry Farm. Ingredients used in large quantities were weighed on a portable platform scale. Ingredients used in smaller quantities were weighed on an analytical balance. The vitamins and minerals were premixed separately in a closed container using soybean meal or ground sorghum grain as the base. The vitamin and mineral supplements were then added to the basal ingredients. The diets were mixed in a small, horizontal-type mixer for approximately 15 minutes.

Portions of each diet were weighed and placed in covered cans. The cans were labeled according to their appropriate lot number. The sorghum grains were obtained from grain dealers. The varieties used were certified seed, hence the identity of each variety was known.

Table 1. Composition of diets fed.

Ingredients	Pounds
Sorghum	65.00
Alfalfa meal (17% dehydrated)	1.50
Soybean oil meal (44% solvent extract)	24.50
Menhaden fish meal	1.00
Wheat standard middlings	4.00
Calcium carbonate	1.50
Salt (NaCl)	0.50
Bone meal (special steamed)	1.00
Vitamin mix*	1.00
Total	100.00
Added per 100 pounds of feed	
Manganese sulfate	25.00 g

* Vitamin A (NOPCAY) 40.00 g (10,000 USP units of vitamin A per g of supplement)

Vitamin D (Sterol D_3) 20.00 g (1,500 I. C. units of vitamin D_3 per g of supplement)

Riboflavin mix (1 oz = 1 g) 10.00 g

Choline chloride (25% mix) 80.00 g

Niacin (Crystalline) 10.00 g

Calcium pantothenate (Crystalline) 1.00 g

"Aurofac" 126.00 g (1.8 mg B_{12} and 1.8 g aureomycin/chlortetracycline per lb of supplement)

Soybean oil meal (filler) 167.00 g

Total 454.00 g

During the first four weeks, the chicks were fed mash; whereas, the last five weeks of the experiment the birds were fed mash and whole grain. The experiments were terminated at the end of nine weeks.

Experiment I - Palatability

Experiment I was conducted in the South Brooder House at the College Poultry Farm. The 150 day-old, unsexed chicks were placed in the 7 3/4 by 10 foot brooder pen. The heat was supplied by an electric brooder. The starting temperature was 90 degrees Fahrenheit. The temperature was lowered approximately five degrees each week.

Nine varieties of sorghum grains were used in the palatability experiment. They were: Atlas, Hegari, Martin, Midland, Westland, K44-14, Plainsman, Pink Kafir, and K60.

The nine different mashes were placed on flats on the floor for the first three days. Every morning the feeders and flats were moved in a systematic manner (Plate I). This was done so that no position (such as feeder nearer the brooder, light, or waterer) would influence the consumption of feed.

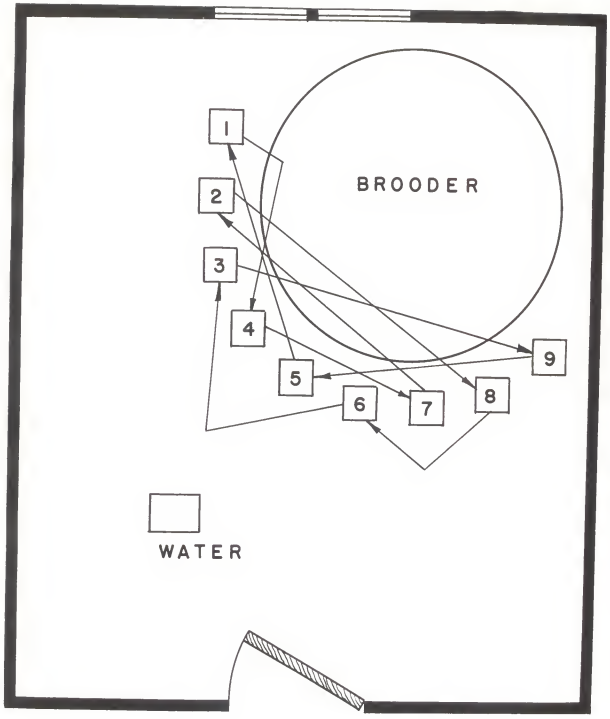
Small hoppers were provided as well as the flats. After three days, the flats were removed. The flats and hoppers were identified by number, which corresponded to the number on the diet storage can. The small hoppers were adjusted from time to time to correspond with the size of the chicks. Gravitation fed waterers were provided. They were cleaned each morning and fresh water was placed before the chicks. Gradually the chicks were induced to drink from automatic waterers.

The chicks were vaccinated with live virus Newcastle at the age of one week and at the age of five weeks. This was administered in the form of a dust spray by use of a dust gun.

EXPLANATION OF PLATE I

Method of rotating flats and feeders in one pen.

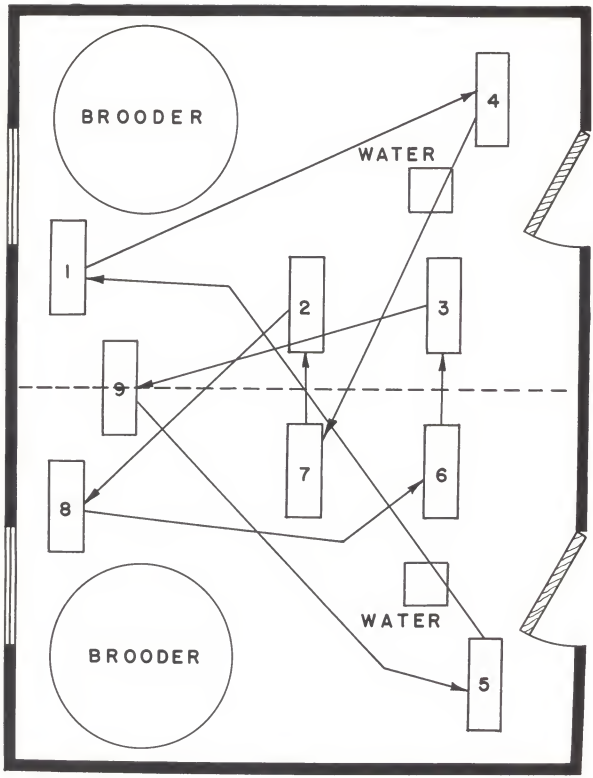
PLATE I



EXPLANATION OF PLATE II

Method of rotating feeders in two pens.

PLATE II



At the age of four weeks, the whole grain was added. Each whole grain hopper was kept adjacent to and rotated with the mash hopper containing the same variety of sorghum.

At the age of four weeks, the chicks were permitted to occupy two pens. This was done to give more room for the growing chicks. This was accomplished by removing the board separating the two pens. Before this was done, the brooder in the adjacent pen was adjusted and the automatic waterer was adjusted. Plate II illustrates the position of the feeders in the two pens and the manner of rotation. (Note that the birds had free access to either pen.)

Experiment II - Efficiency

Experiment II was conducted in the Poultry Nutrition Laboratory at the College Poultry Farm. Room temperature was maintained between 70 and 75 degrees Fahrenheit by thermostatically controlled gas stoves. The last five weeks, no heat was provided for the birds because it was during the months of July and August. Fourteen hours of light were provided daily by an automatic time clock.

A six-tier battery with 12 separate compartments was used. The heaters for each compartment were adjusted to lower temperatures as the chicks grew. The waterers and feeders were also adjusted in keeping with the growth of the chicks. At five weeks of age, the chicks were transferred to the growing batteries.

In this experiment, 192 day-old White Plymouth Rock chicks

Table 2. Analysis of variance of palatability of mash.

Source of variation	Degrees of freedom	Mean square
Varieties	8	16.78**
Weeks	8	98.64**
Interaction (Error)	64	4.25

** Highly significant-P<.01

The analysis of variance demonstrated that there was a highly significant difference between varieties. The total amount of mash consumed over the nine-week period, mean consumption, and regression coefficients are presented in Table 3. The least significant difference was 1.94. If the means listed in the table are bracketed, they are considered homogeneous.

Table 3. Total amount mash consumed, means, and regression coefficients.

Variety	Regression coefficient	Total amount	Mean
K44-14	2.059	98.45	10.94
Midland	1.654	90.75	10.08
Martin	1.283	83.60	9.29
Westland	1.249	79.20	8.80
Pink Kafir	0.836	74.45	8.27
Plainsman	1.166	69.12	7.68
Atlas	1.059	67.80	7.53
Hegari	0.575	64.85	7.21
K60	0.914	62.50	6.94

Generally, the variety with the largest regression coefficient was the one which the birds consumed the most. The two varieties which do not conform to this rule are: Pink kafir and K60. Although Pink Kafir ranks fifth in palatability, it has the lowest regression coefficient. K60 ranks last in palatability, but the regression coefficient is third from the lowest.

The regression coefficient indicates the average increase per week of feed consumption. Since such a wide discrepancy exists among the various regression coefficients, an analysis of the errors of estimate from the average regression within groups was calculated, and is presented in Table 4.

Table 4. Analysis of errors of estimate from average regression within groups.

Source of variation	Degrees of freedom	Mean square
Deviations from individual lot regressions	63	3.02
Difference among regressions	8	11.85**

** Highly significant-P<.01

A study of the data presented in Table 4 reveals that there were highly significant differences among the regression coefficients. Since the regressions did not appear to be homogeneous, it was determined which regressions were not of the same population. The data recorded in Table 3 show that there was one regression which was extremely small, and one which was extremely large. It was discovered that these two varieties had to be

removed in order to have homogeneous regressions from the other varieties. Data tabulated in Table 5 show an analysis of the regression with Hegari, and K44-14 deleted.

Table 5. Analysis of errors of estimates from average regression within groups (except Hegari and K44-14).

Source of variation	Degrees of freedom	Mean square
Deviations from individual lot regressions	49	2.50
Difference among regressions	6	4.40

Tabulations presented in Table 5 indicated that the regressions fall into three classes. The one which showed the most gain in consumption per week was K44-14. Hegari showed the least gain in consumption per week. The rest were homogeneous and fall between the two extremes.

Keeping in mind that the gains per week are not all homogeneous, the order of palatability for the varieties in the form of mash will be utilized as listed in Table 3. With exceptions of the regression coefficients of Pink Kafir and K60, varieties with the largest regression coefficients were the ones which the birds consumed the most. The varieties with the lowest regression coefficients were the ones which the birds apparently liked the least.

Analysis of variance of the data for palatability of the sorghum grains is presented in Table 6. The analysis indicated a significant difference (to the 5 percent level) in the amounts

of grain consumed. There was a non-significant difference in the grain consumption by weeks.

Table 6. Analysis of variance of palatability of grain sorghums.

Source of variation	Degrees of freedom	Mean square
Varieties	8	1.97**
Weeks	4	0.23
Interaction (error)	32	0.82

* Significant-P<.05

Data tabulated in Table 7 reveal the order of palatability of sorghum grains. In addition, total consumption, average consumption per week, and the regression coefficient are presented.

Table 7. Total amount and mean consumption of nine grains, with the regression coefficient (4-9 weeks).

Variety	Regression coefficient	Total amount	Mean
K60	-0.35	15.80	3.16
Pink Kafir	+0.09	11.60	2.32
Martin	-0.08	11.58	2.32
K44-14	-0.30	11.50	2.10
Westland	+0.28	11.20	2.04
Plainsman	+0.76	11.20	2.04
Atlas	-0.09	9.85	1.97
Hegari	-0.51	5.70	1.14
Midland	-0.16	5.40	1.08

The least significant difference between the means was 1.16. The means which are bracketed indicated that they are non-heterogeneous.

An observation of the regression coefficients indicated that they can be divided into two groups. The extreme (Plainsman) can be deleted and the others may be grouped together. The homogeneity of all the regressions were tested and the calculations are listed in Table 8. Data presented in Table 8 reveal that the above statement (that the regressions are not all homogeneous) is true.

Table 8. Analysis of errors of estimate from average regression within groups.

Source of variation	Degrees of freedom	Mean square
Deviation from individual lot regression	27	0.57
Difference among lot regressions	8	1.44*

* Significant-P<.05

The computations tabulated in Table 8 reveal that the regression coefficients are not from the same population. There was a significant difference between them. As indicated before, when an analysis of errors of estimate from the average regression within groups was calculated for all varieties, with the exception of Plainsman, it was found that they were homogeneous. Calculations for all varieties except Plainsman, are shown in Table 9.

Table 9. Analysis of errors of estimate from average regression within groups (except Plainsman).

Source of variation	Degrees of freedom	Mean square
Deviation from individual lot regression	27	0.55
Difference among lot regressions	8	0.74

There was more inconsistency in rate of consumption of grain than there was with mash. The negative regression coefficients indicated this fact. Westland and Plainsman indicated a rapid increase in consumption rate, but they were not among varieties which were apparently most palatable.

The third phase of the analysis determined consisted of combining the two physical forms of the varieties. An analysis of variance of the data was calculated for the combined totals of mash and grain. Computations for the analysis of variance are tabulated in Table 10.

Table 10. Analysis of variance of palatability of combination grain and mash.

Source of variation	Degrees of freedom	Mean square
Varieties	8	16.78**
Weeks	8	98.64**
Interaction (error)	64	4.25

** Highly significant-P<.01

An analysis of variance of the data indicated that palatability of both sorghum grain and mash was highly significant (to the 1 percent level). The order of palatability of the varieties is presented in Table 11.

Table 11. Order of palatability of varieties of sorghum grain and mash, regression coefficient, total consumption, and mean.

Variety	Regression coefficient	Total consumption	Mean consumption
K44-14	2.40	108.95	12.10
Midland	1.81	96.15	10.68
Martin	1.66	95.18	10.58
Westland	1.64	89.40	9.93
Pink kafir	1.19	84.65	9.41
Plainsman	1.68	80.72	8.97
K60	1.38	78.30	8.70
Atlas	1.37	77.63	8.63
Hegari	0.68	70.55	7.84

The least significant difference for the combination of mash and grain was 2.13. The brackets in Table 11 indicate the means which are non-heterogeneous.

The regressions do not appear homogeneous for the varieties when the mash and grain are combined. An analysis of errors of estimate from average regression within groups, listed in Table 12, illustrates this fact.

Table 12. Analysis of errors of estimate from average regression within groups (for all varieties with combination of grain and mash forms).

Source of variation	Degrees of freedom	Mean square
Deviation from individual lot regression	63	3.79
Difference among lot regressions	8	13.31**

** Highly significant-P<.01

Results of the analysis summarized in Table 12 shows that there is a highly significant difference between regressions. The observation was made that if the variety with the smallest regression was removed, the remaining regressions were homogeneous. These computations are presented in Table 13.

Table 13. Analysis of errors of estimate from average regression within groups (Hegari deleted).

Source of variation	Degrees of freedom	Mean square
Deviation from individual lot regression	56	4.01
Difference among lot regressions	7	8.22

With the deletion of Hegari (the variety with the smallest coefficient), the remaining regression coefficients were homogeneous.

The more palatable the variety, the greater was the average increase per week of feed consumption. This statement was true

with the exception of Pink Kafir, and to some extent, Plainsman. Hence, the more palatable the feed, the tendency was present for the palatability to increase with each week.

An attempt was made to find if there was any similarity between the consumption of mash and the consumption of grain. The rankings of the consumption of mash, grain, and the combination are listed in Table 14.

Table 14. A comparison of the consumption of mash, grain, and the combination.

Mash	Grain	Combination
K44-14	K60	K44-14
Midland	Pink Kafir	Midland
Martin	Martin	Martin
Westland	K44-14	Westland
Pink Kafir	Westland	Pink Kafir
Plainsman	Plainsman	Plainsman
Atlas	Atlas	K60
Hegari	Hegari	Atlas
K60	Midland	Hegari

A study of the data presented in Table 14 raises unanswerable problems. In a few varieties such as Atlas, Hegari, and Plainsman, the position remained constant with reference to mash and grain. In contrast to this, K60 was the least palatable sorghum mash; whereas, the variety ranked first when fed as a grain. The combination was almost in complete agreement (with the exception

of K60) with the palatability of mash. The reason for the agreement is because there was more mash consumed than grain. One reason that the grain seems to erratic, in relation to the palatability of the mash, may be explained by the negative regression coefficients which were obtained.

Of the 150 chickens placed in the pen, there was a death loss of only seven birds. Two other birds were definitely retarded in their growth. Their poor gain was attributed to the fact that they had perosis.

Experiment II - Efficiency

Results for Experiment II are divided into the following phases. The different gains of the chickens for the varieties are discussed, the amount of feed consumed is shown, and the feed conversions for the six varieties are given. The amount of feed consumed is divided into three parts: mash, whole grain, and combination of mash and whole grain for each variety.

Before an analysis was conducted to determine the significance of the gains per lot, it was necessary to determine the correlation between the initial weight of the birds and that of their total gain (nine weeks' gain). It was considered essential to determine what effect the initial weight would have upon the total gain of the chickens.

Since a difference in rate of gain existed between the two sexes, the birds were divided into sex-lots. Hence there were 24 sex-lots to be correlated. Interpretation of data presented in Table 15 reveals results of the correlations between each

sex-lot.

Table 15. Correlation coefficients for the sex-lots.

Lot	Variety	Males		Females	
		Number	r#	Number	r#
1	Atlas	8	+0.56	8	+0.51
2	Hegari	12	-0.07	4	-0.15
3	Martin	9	-0.46	7	-0.06
4	Midland	6	+0.40	10	-0.20
5	Westland	7	-0.14	9	+0.35
6	K44-14	6	+0.33	10	+0.11
7	Atlas	6	+0.80(*)	10	+0.41
8	Hegari	10	+0.14	6	+0.48
9	Martin	6	-0.86*	10	+0.33
10	Midland	9	-0.52	7	+0.56
11	Westland	8	+0.22	8	+0.11
12	K44-14	7	+0.44	9	+0.17

Correlation coefficient
* Significant-P<.05
(*) Almost significant-P<.05

Results indicated that there was one sex-lot where the correlation was significant to the 5 percent level. Another was found to be almost significant to the 5 percent level. The remaining 22 sex-lots were not considered significant. From this it became evident that the initial weights were not a factor to be considered in the analysis of the total gain of the sex-lots.

Because of the unequal distribution of sex within each of

the 12 lots (Table 15), in order to analyze the gains, it became necessary to utilize the harmonic mean.

First, the means of the 24 sex-lots were calculated. Table 16 lists the mean weights for the sex-lots. An analysis of variance was run on means alone. The factors involved were: diets, sex, replication, and experimental error. Data tabulated in Table 17 shows the analysis of variance of means of sex-lots.

Table 16. Means of the 24 sex-lots.

Lot	Males	Females	Lot	Males	Females
1	809.13	654.25	7	778.17	663.20
2	715.33	625.50	8	696.10	607.50
3	909.56	760.57	9	817.83	667.50
4	779.00	648.80	10	873.56	731.14
5	843.00	693.11	11	818.75	690.13
6	858.50	653.20	12	865.86	662.00

Table 17. Analysis of variance of means of 24 sex-lots.

Source of variation	Degrees of freedom	Mean square
Diets	5	8,001.38*
Sex	1	121,537.01**
Replication	1	229.47
Diet x sex interaction	5	1,364.61
Experimental error	11	1,566.88

* Significant-P<.05
** Highly significant-P<.01

The harmonic mean was calculated to weight-up the sum of squares for experimental error to determine if the analysis of variance for the means could be used. The harmonic mean was calculated as follows: by adding the reciprocals of the number of chickens in each sex-lot, and dividing the total number of sex-lots by the summation of the reciprocals. The resulting figure is the harmonic mean which is multiplied by the experimental error.

The sampling error of the experiment was calculated by summation of the corrected sum of squares of each sex-lot. Since the experimental error had been weighted-up, it could be compared with the sampling error to determine if the analysis of variance of the means of the sex-lots was valid (Table 18).

Table 18. Analysis of variance of sampling error and experimental error.

Source of variation	Degrees of freedom	Sum of squares	Mean square
Experimental error	11	130,129.69	11,829.97
		(17,235.72 x 7.55)	
Sampling error	168	1,665,190.03	9,911.85

Data recorded in Table 18 show that the experimental error was not significantly greater than the sampling error, hence the analysis of variance as shown in Table 17 can not be considered as valid.

Data listed in Table 19 reveal the total amount of mash consumed in each of the 12 lots. It must be remembered that during

the last five weeks the birds were permitted to consume, free-choice, the corresponding whole grain. Data recorded in Table 20 show the amount of whole grain consumed the last five weeks for each lot. Consumption and ranking of the combination of mash and grain are presented in Table 21.

Table 19. Consumption of mash for 12 lots (in pounds).

Variety	Lot	Amount	Lot	Amount	Total	Ranking
Atlas	1	67.27	7	61.81	129.08	4
Hegari	2	65.95	8	62.38	128.33	5
Martin	3	65.95	9	59.97	125.92	6
Midland	4	60.95	10	72.17	133.12	1
Westland	5	68.69	11	61.27	129.96	2
K44-14	6	63.73	12	65.40	129.13	3

Table 20. Consumption of whole grain for 12 lots (in pounds).

Variety	Lot	Amount	Lot	Amount	Total	Ranking
Atlas	1	4.05	7	3.71	7.76	3
Hegari	2	1.42	8	2.09	3.51	6
Martin	3	10.18	9	6.40	16.58	1
Midland	4	5.45	10	1.98	7.43	4
Westland	5	4.93	11	5.21	10.14	2
K44-14	6	2.85	12	3.34	6.19	5

Table 21. Consumption of combination (whole grain and mash) for 12 lots of chickens.

Variety	Lot	Amount	Lot	Amount	Total	Ranking
Atlas	1	71.32	7	65.52	136.84	4
Hegari	2	67.37	8	64.47	131.84	6
Martin	3	76.13	9	66.37	142.50	1
Midland	4	66.40	10	74.15	140.55	2
Westland	5	73.62	11	66.48	140.10	3
K44-14	6	66.58	12	68.74	135.32	5

The tables represent the different amounts of feed consumed when the birds were forced to eat only one ration. An analysis of variance was calculated for each of the above tables. The analysis of variance for mash is shown in Table 22; whereas, the analysis of variance of grain and the analysis of variance of mash and grain consumptions are presented in Tables 23 and 24, respectively.

Table 22. Analysis of variance of mash consumption.

Source of variation	Degrees of freedom	Mean square
Between varieties	5	2.75
Within varieties	6	21.84

Table 23. Analysis of variance of whole grain consumption.

Source of variation	Degrees of freedom	Mean square
Between varieties	5	9.98*
Within varieties	6	2.27

* Significant-P<.05

Table 24. Analysis of variance of combination (mash and grain).

Source of variation	Degrees of freedom	Mean square
Between varieties	5	7.75
Within varieties	6	21.09

The analysis of variance for mash and grain combined, and mash alone revealed no significant difference. However, when the analysis of variance was computed on the grain consumption alone, it was observed that there was a difference at the 5 percent level.

Since the difference existed at the 5 percent level, the least significant difference was computed. The least significant difference for the means of the grain consumption was 3.69. Hence there was a significant difference in the consumption of Martin and Atlas, Martin and Midland, Martin and K44-14, Martin and Hegari, and Westland and Hegari.

The third set of computations calculated for the efficiency experiments were the feed conversion values for each lot, and for each variety. Since the feed was weighed in pounds, and the

chicks' weights were recorded in grams, the gain of the chickens was converted into pounds. This was accomplished by dividing the number of grams gained by the number of grams in a pound. The number of pounds of feed consumed was divided by the number of pounds which the lot gained. Data recorded in Table 25 reveal the figures for the feed conversions of the different lots, the averages for the variety, and the ranking.

Table 25. Feed conversion for the 12 lots.

Variety	Lot	Feed conversion	Lot	Feed conversion	Average feed conversion	Ranking
Atlas	1	2.77	7	2.63	2.70	5
Hegari	2	2.76	8	2.76	2.76	6
Martin	3	2.56	9	2.60	2.58	1
Midland	4	2.70	10	2.59	2.65	4
Westland	5	2.75	11	2.50	2.63	3
K44-14	6	2.59	12	2.59	2.59	2

One further statistical test was conducted, which was to determine if the feed conversions of the lots were significantly different. Data reported in Table 26 show the analysis of variance for the feed conversion of the 12 lots. As can be seen by a study of the data presented in the table, there were no significant differences between the various lots.

Table 26. Analysis of variance of feed conversions of the lots.

Source of variation	Degrees of freedom	Mean square
Between varieties	5	0.010
Within varieties	6	0.008

In the efficiency experiment, there was no mortality other than one bird which was killed accidentally in Lot 11, and one bird which was killed in Lot 12 because of a perosis condition. Gain and feed consumption data for the missing birds was calculated and included in the computations. Mortality was not a factor that could be utilized in deciding efficiency of the varieties of sorghum grains.

DISCUSSION

Chickens prefer certain feeds over others. Palatability is a factor which needs consideration in the science of poultry feeding.

The results indicate that color has apparently little if any influence upon the selection of a particular variety. In the consumption of the mash, the white varieties were both first and last in order. For example, K44-14 was first in preference, and K60 was last. Pink Kafir, a pink-white variety, was sixth, and Hegari, a chalk-white variety, was eighth in palatability.

Comparing the palatability of sorghum grain, it was observed that K60, a white variety, and Pink Kafir, a pinkish-white variety, were the most palatable. Three white varieties, namely

K44-14, Atlas, and Hegari, ranked third, seventh, and eighth, respectively. Since Atlas is a forage sorghum, it may be a plausible explanation why it was consistently an unpalatable sorghum variety.

The findings, that color apparently has little if any effect upon palatability, are consistent with the results obtained by Newbiggin and Linton (1927), Anderson and Briggs (1948), and Engelmann (1940).

Thayer (1956) reported that white sorghum grains were more palatable than the dark seed-coated. This was not substantiated by the results from this experiment.

Kennard and Nettleton (1927) and Hinds (1937) concluded that chickens preferred granular or grain-like feed. The results obtained in this investigation do not substantiate their findings; however, young chickens (four to nine weeks of age) were used in this study. Another reason why the results differ may be the fact that the sorghum mash had ingredients in addition to the grain. Other factors were present to increase the palatability of the mash.

There was no close relationship between the consumption of mash and grain. The variety which was most palatable when fed as whole grain was least palatable when fed as a mash (Table 14). Some varieties were consistent with reference to grain and mash consumption. In other words, the varieties investigated did not have the same ranking when fed as a mash, as when fed as a grain. The birds were young (4 to 9 weeks) hence the mash totals appear more reliable.

The grain which was the most palatable did not have the highest regression coefficient. In fact, a majority of the regression coefficients were negative. One possible explanation for this fact was that the sorghum grain was added to the mash. Birds are attracted toward something new at first, and when the newness has worn off, the grain became less palatable.

Three varieties used in this palatability study were previously fed to swine by Aubel and Swanson (1951). Westland ranked first in palatability for swine and ranked fourth for chickens, when fed as a mash or as a grain. Midland and Martin ranked fourth and fifth for the swine. Chickens preferred Midland and Martin mash in second and third place; however, Midland grain was least consumed, and Martin grain ranked third. A cross, Leoti x Atlas, ranked last for the swine; whereas, Atlas grain and mash both ranked seventh (third from the last) for chickens. With these few comparisons, it would appear that there was not a great similarity between the palatability of sorghum grains for swine and chickens.

With reference to efficiency, Duitsman and Kessler (1955) concluded that in feeding either Midland or Martin grain sorghum, there apparently was no difference in gains for cattle between the two varieties. This observation was substantiated in this investigation with chickens. In one replicate, the Martin caused superior gains; whereas, in the other replicate, Midland caused the greater gains. Not only was there a non-significant difference between the gains of these two varieties, but there were non-significant differences in gain among all the varieties.

Observations reported by McClymont and Duncan (1952) indicated that there was a toxic substance present in grain sorghums. Although definite conclusions should not be made from these experiments, the observations appeared to substantiate their report. Although good feed conversions were obtained in the efficiency experiment (2.50 to 2.77), it was evident that there was poorer growth than usual.

The fact that there was no significant difference between the varieties from this standpoint is important. With the exception of the consumption of grain, the consumption of mash, consumption of combination (mash and grain), gain, and feed conversion were all non-significant. This would indicate that it is not important which feed is fed, because the birds apparently do equally well on all varieties.

Though there was a significant difference in palatability of sorghum varieties, this should not be used as a single criteria in selection of varieties to be used. For example, the forage sorghum, Atlas, was as efficient as the most palatable grain variety, K44-14. From the standpoint of feeding chickens, the varieties perform in the same manner; therefore, it would not be necessary to recommend feeding only the most palatable varieties.

SUMMARY AND CONCLUSIONS

Two experiments were designed to test the palatability and efficiency of various sorghum varieties. The following are the results observed in these experiments.

1. Chickens prefer some feeds more than others. The results indicated that some varieties were more palatable than others.

2. Sorghum varieties fed in the form of mash which were most palatable did not necessarily have the same ranking when fed as whole grain.

3. Ranking of varieties when fed as mash were: K44-14, Midland, Martin, Westland, Plainsman, Pink Kafir, Atlas, Hegari, and K60. Ranking of varieties when fed as whole grain were: K60, Pink Kafir, Martin, K44-14, Westland, Plainsman, Atlas, Hegari, and Midland. Combination of mash and grain feeding of sorghum varieties resulted in the following ranking: K44-14, Midland, Martin, Westland, Pink Kafir, Plainsman, K60, Atlas, and Hegari.

4. Varieties, when fed as a mash, which were most palatable had the highest positive regression coefficient, and varieties which were the least palatable had the lowest positive regression coefficient. The varieties which were more palatable became increasingly more palatable with each ensuing week. Varieties which were least palatable increased in palatability but more slowly. This was not true when the varieties were fed as a whole grain. No relationship seemed to exist. However, the pattern alluded to in the mash feeding seemed to hold true even to a greater extent when the grain and mash totals were combined.

5. No significant differences were obtained among the six lots from the standpoint of gains, feed consumption, or efficiency, with the exception of grain feed consumption. This was obscured when the mash and grain were combined. Hence, with

reference to feed efficiency, all varieties tested were homogeneous, or non-significantly different.

6. The feed conversions were considered excellent. They ranked from 2.50 to 2.77.

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A COMPARISON OF THE PALATABILITY AND EFFICIENCY OF PRODUCTION OF VARIOUS SORGHUM GRAINS FOR CHICKS

by

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The purpose of these experiments was to determine the differences between the various sorghum grains relative to palatability and efficiency. Normal Poultry Husbandry practices were observed in conducting the experiments. A standard mash was fed to the chicks from the age of one day to nine weeks. The variable in the mash was the variety of sorghum. The chicks were fed grain in addition to the mash starting with the fifth week. The palatability experiment was conducted on the floor of the South Brooder House. The various hoppers were interchanged systematically each morning. The efficiency experiment was conducted in batteries in the Poultry Nutrition Laboratory.

There were significant differences in the palatability between the various sorghum grains. When fed as a mash, the ranking was as follows: K44-14, Midland, Martin, Westland, Pink Kafir, Plainsman, Atlas, Hegari, and K60. The last five weeks of the nine-week palatability experiment, the whole grain was added in separate hoppers. The ranking of the varieties when fed as whole grain was as follows: K60, Pink Kafir, Martin, K44-14, Westland, Plainsman, Atlas, Hegari, and Midland. Combination of the grain and mash feeding of sorghum varieties resulted in the following ranking: K44-14, Midland, Martin, Westland, Pink Kafir, Plainsman, K60, Atlas, and Hegari. Varieties which ranked high when fed as a grain, did not necessarily have that ranking when fed as a mash. Usually the varieties when fed as a mash, which were palatable, were also the ones which had the highest regression coefficient. This was not true in the case of the grains. Palatability was not affected by color.

In the efficiency experiment the following varieties were used: Atlas, Hegari, Martin, Midland, Westland, and K44-14. There was a significant difference found in the consumption of grain, but there was no significant difference in the consumption of mash or the combination of mash and grain. No significant differences were found in the gain of the birds from the different lots nor was there a significant difference in the feed conversion. The feed conversions were from 2.50 to 2.77.

It was concluded that it did not matter which variety was fed, despite the fact that one may be more palatable than another because the varieties gave the same feed conversions and gain.