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The effect of feed transportation distance and feeding management (cylindrical feeder vs. automatic feeder) on the durability and length of broiler pellets.

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Abstract

Pellets have advantages over mash, but the amount lost due to disintegration into small, fine particles exceeds 10% of the amount provided in the feed meal, which is undesirable from an economic standpoint. Therefore, the aim of the study. Finding the effect of the distances of transporting feed pellets from factories to fields (443 km, 463 km, and 595 km) and The effect of eating the feed offered to chickens (cylindrical feeders and automatic feeding lines) on the durability and length of the pellets and evaluate the performance of the locally manufactured durability testing device. The results show that is an effect of the transportation distance on the durability of the pellets, which does not exceed 2.5% if the distance exceeds 150 km and 50% of the full length can be retained. The line of feeding is superior to traditional methods. The method of providing feed using the cylindrical feeder recorded a high percentage of dust and broken particles, less than 3 mm.

Key words:* *Pellets , durability , chicken's feeder, fine particles .

1 - Introduction

Pellet has become the most widespread and preferred method of feeding farm animals. Feed pellets are distinguished from mash feed by adding unpalatable and very fine ingredients (such as concentrated food additives and medicines) to the pellet manufacturing paste. This manufacturing method prevents the animal from separating the preferred particles, while the feed in the form of mash can easily separate its components by the animal and leave the preferred particles, which leads to wastage of feed, in addition to the preference for large-sized particles (larger than 2-8 mm) by the chicken regardless About the quality of feed in terms of nutritional value [1]. Although there is no effect of providing the feed meal in the form of pellets or mash on the feed conversion factor and consumption rate [2], pellets are the least wasted and the best physical formula for feeding chickens due to their well-known advantages [3]. Any field owner and scientific researcher seeks to avoid wasting feed (mash or pellets) because feed constitutes more than 70% of the total production cost. There are many reasons for wasting feed, and the researcher [4] divided them into direct and indirect causes. The loss of feed through direct causes ranged from 5-15% of the total feed consumed annually, and we can estimate that 4% is due to volatile feed such as dust and falling on the litter (waste). As for the indirect causes, they are estimated at a rate ranging from 11-22% and are due to excessive nutrition, diseases, and poor environment.

There are many factors that affect feed loss in the form of dust, feed loss, pecking and separation of components by chickens. The method of manufacturing feed pellets and the type of raw ingredients included in the feed dough have a major role in the final physical specifications of the feed, such as durability, hardness, lengths of the pellets, and their density. The percentage of breakage in feed pellets

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increases as the durability of the pellets decreases. [5] found that pellets have advantages over mash, even if the durability index of the pellets decreases. Pelletization reduces feed waste in the form of dust [6] but the amount lost due to disintegration into small, fine particles exceeds 10% of the amount provided in the feed meal, which is undesirable from an economic standpoint.

Feed pellets for feeding chickens are manufactured in the form of cylindrical particles whose length is not less than three times their diameter, and thus are in sizes appropriate to the desires of the chickens. Feed handling and transportation processes are considered among the factors affecting the durability of the pellets and maintaining the desired length. Many scientific researches were conducted with the aim of simulating the effect of transport and handling operations of feed, and many devices appeared to measure the durability of pellets, such as the drop box device of different types and the air tube device. The strength of the pellets is usually estimated as a percentage of the weight of broken to whole pellets, or expressed by dividing the ratio of fine pellets to whole pellets (90%: 10%), as the fine pellets should not exceed 10%. Feed efficiency is predicted to decline by 1% for every 10% increase in pellet fines[7] . [8] studied the effect of repeated circulation of pellets between two storage bins on the durability of the pellets. He used 22.6 tons of feed pellets at a flow rate from one tank to the other of the order of 62.2 tons/hour. He found a decrease in the average geometric diameter of the pellets due to the effect of the repeated circulation process, at a rate of 4% for each circulation process. While no significant effect was found on the durability index, which was 92.9%. The percentage of fines generated during truck unloading tended to rise from the front to the rear compartment but was unaffected by unloading speed [9] On the chemical-physical properties of pelleted feed for broiler chickens at the end of production, the effects of feed transportation and the use of an automated feeding system were assessed. According to the findings, transportation had a detrimental effect on the physical feed quality. More pellet breakdown and de-mixing occurs as a result of feed truck unloading at the silo, which is the primary factor affecting its physical quality [10].

We have noticed that the quality of the feed and its effect on the weight gain of chickens encourage breeders to buy it despite the large distance between the feed mill and the location of the field. On the other hand, there are unscientific methods for providing feed meals to chickens, such as adding feed cumulatively to the remaining feed from previous meals, which increases the percentage of fine particles at the bottom of the feeder. This method affects the palatability of the new feed meal, in addition to its contamination and the feeder being filled more than half of its capacity, which It results in a loss in the amount of feed due to it falling from the feeder. Therefore, the following objectives were determined for the study.

Finding the effect of the distances of transporting feed pellets from factories to fields on the physical quality of feed and The effect of pecking and eating the feed offered to chickens in different ways (cylindrical feeders and automatic feeding lines) on the durability and length of the pellets, to enrich knowledge about the causes of feed waste and help find solutions to reduce feed losses and evaluate the performance of the locally manufactured durability testing device.

2 -Materials and working methods

2 -1 Transportation distances from the factory to the fields

Feed samples were taken from one of the factories in Baghdad Governorate, and the durability of the feed was examined by separating the whole grains from the dust and the broken grains of less than 3 mm using a sieve No. 1/8 (3.17 mm). The length of the feed grain was also measured (the factory produces grains with a diameter of 4 mm and a standard length of 10 mm). Then the samples (3 samples) were transferred to three fields that differed in distance from the factory. The experiment was designed with 3 transport distances (443 km, 463 km, and 595 km) x 3 replicates. Distances were measured in kilometers using Google Maps to determine the target location and direct the route.

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2 – 2 Pellets durability testing device

The durability testing device was manufactured in the scientific department workshop according to the standard specifications of the Tumbling box device, 50 revolutions/minute, test time 10. The durability of three samples of factory feed was tested by the device according to the instructions of ASAE Standard ASAE S269 [11] First, the three feed samples were sieved to get rid of dust and particles smaller than the diameter of the sieve mesh holes (feed samples with a diameter of 4 mm were sieved using sieve No. 1/8 (3.17 mm)). Then the amount remaining on the sieve of each sample was weighed, and 500 grams of each sample remaining on the sieve were isolated to be placed in the feed pellet durability testing device using the drop box device. After 10 minutes (test time) had passed, the sample was extracted and then sieved using the same sieve used before the test. Then the amount that remained on the sieve was weighed. The following equation was used to calculate the durability index of pelleted feed

$$\text{Durability (\%)} = \frac{Mass\ of\ pellets\ after\ tumbling}{Mass\ of\ pellets\ before\ tumbling}\times 100 \quad \ldots (1)$$

After transporting pellet samples to fields that are different distances from the factory. The strength of the pellets tested by the device before being transported to the fields was compared with the strength of the samples after being transported. The strength of the pellets was measured by separating with a 1/8 mm sieve, not by the device. During transportation, samples are exposed to loading and unloading, circulation transportation devices, and the automatic feed delivery system (feeding lines). After that, the durability results of the pellets for the pairs of samples (before and after transportation) were compared using the paired sample T-test.

2 – 3 Pecking and eating pellets by chickens (cylindrical feeders and automatic feeder)

A field was chosen for raising broiler chickens, in which birds are fed using cylindrical feeders with a capacity of 10 chickens, and another field in which birds are fed using automatic feed lines, with a capacity of 10 chickens per feeder. The two fields use feed from the same factory and with the same specifications. Each field was divided into three areas (beginning, middle, and end) and 3 samples were taken from each area. The T-test was used to compare the average feed durability and the average ranges of pellet length.

2- 4 Measuring the lengths of feed pellets

Pellets are manufactured with a length of up to three times the diameter. In the samples used in the current research, the maximum length was 10 mm (for feed with a diameter of 4 mm). The length was measured on the basis of four ranges, including the range 3 - 4 mm as the smallest size palatable to chicken meat, and then the range 5 - 6 mm, 7 - 8 mm, and the maximum length range is 9 - 10 mm. The measurement was based on taking 100 grams of feed samples remaining on the sieve (not passing through the mesh holes) after the end of the durability test. Then the particles were separated according to the four length categories mentioned above. A sheet of cardboard was divided into length categories, and by placing the particles on these divisions, their lengths could be known. After separating the pellet particles according to length categories, they were counted and then the percentage of each length category from the total number of particles in the sample was extracted. Counting was used instead of weight because the percentage of some length categories, especially full-length particles (10 mm), are present in small numbers, and therefore the weight of these categories is very small and requires a sensitive balance, which may be estimated, leading to an increase in the standard error. The length ratio of the pellet particles according to the specified length category was calculated using the following relationship.

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3 - Results and discussion

3-1 The results presented in the first column of Table 1 show that the durability of the pellets manufactured in the factory under study was characterized by high quality at a rate of 99.1%, and the percentage of dust and particles less than 3 mm in it did not exceed 1%. This is due to the influence of many factors on the manufacturing quality, as explained by [12].The moisture content of the studied samples ranged from 4.1 to 5.6% on a wet basis.

table 1 Durability of pellets before and after transportation

Samples for same factor	Durability test before transportation %		Durability test after transportation % using Separation by sieve 3.17 mm
	using Separation by sieve 3.17 mm	using Drop box device	
S1	98.90	98.80	98.70
S2	99.20	99.10	99.01
S3	99.20	97.90	96.60
Average	99.1%	98.60	98.10
Std. Error mean		0.21%	

The pellet durability measuring device is a tool that simulates the effect of transportation and handling conditions on the physical quality of feed. During transportation from the factory until arriving in front of the animals, the feed pellets are exposed to unloading and overloading, as well as road bumps, friction, and shock resulting from being transported by conveyors (augment, bucket, etc.). The T-TEST analysis of the results shown in Table 1 showed a significant difference between the average durability of the pellets before and after transportation, 098.6% and 98.10%, respectively, with a standard error of 0.21%. This result may have been due to the small number of samples or a defect in the performance of the pellet durability measuring device.

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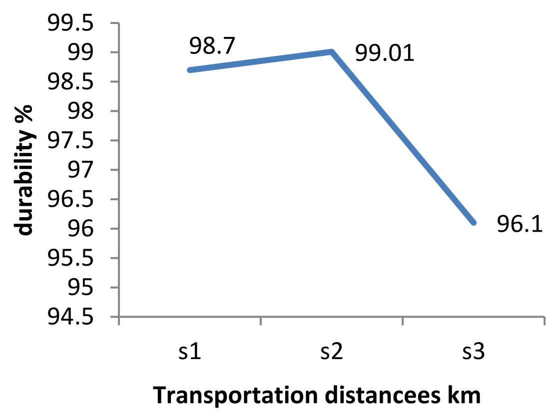

Scheme 1 the effect of transporation distances on the durability of pellets

Scheme 1 Effect of transportation distances on the durability of

pellets, S1 distance 442 km , S2 distance 463 km , S3 distance 595km

3 – 2 The results presented in Chart 1 show that there is an effect of the transportation distance from the factory to the field and the loading and unloading conditions on durability .This result is consistent with (Lorenzetti, W.R.,2019). The distance 442 km and the distance 463 km recorded a significant difference in the durability value of the pellets compared to the distance 595 km, where the latter recorded 96.6%, while the distance 442 km and the distance 463 km recorded pellet durability of 98.7% and 99.01%, respectively. While the distances 442 km and 463 km did not have a significant difference, the reason may be due to the small difference between the two distances, which is 21 km, compared to the difference between the distance 442 km and the distance 595 km, which is 153 km, and the difference between 463 km and the distance 595 km is 132 km. De Jong, J. A. *at el.*,(2017) also proved that transportation affects the durability of the pellets and attributed the reason to the location of the pellets in the truck and the method of unloading them.

When comparing the durability values after transportation over different distances with the initial feed durability value before transportation, 99.1% (Table 1), the one sample t-test shows that there are significant differences between the durability of the samples after transportation and the initial durability before transportation, where the distance of 595 km recorded the largest decrease in durability. The difference was 2.5% from the initial value, but it did not decrease by an unacceptable percentage, as the percentage of 96.6% indicates that the fine to fine grains are 96.6%: 3.4%. We note that the fine percentage of 3.4% did not exceed the undesirable percentage as a standard for the quality of feed pellets of 10%.

3 -3 Table 2 shows the results of the effect of transportation distances on the length of feed pellets broken into four length categories extending from 3 mm to 10 mm. The statistical analysis shows that there is no effect of the transportation distance on the average length of the feed pellet, as distances of 442, 463, and 595 km recorded average lengths of 24 mm, 25 mm, and 24.9 mm, respectively. While there is an effect of distances on each length category separately. There is an effect of distances on the length range from 3 to 4 mm and the range from 5 mm to 6 mm, different from the effect of distances on the two categories from 7 mm to 8 mm and from 9 mm to 10 mm, as the distance of 595 km recorded the highest percentage of the total number of pellets. In the categories 3-4 mm and 9-10 mm, it recorded 3.3% and 62.50%, respectively, as we can see from Table 2. While the lowest percentage of pellet counts

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was recorded in the 5-6 mm length category and 7-8 mm length category, amounting to 5.7% and 28.4%. The reason may be due to unjust throwing of the pellet container, which results in the pellets breaking on the side that is exposed to impact with the roof of the truck or the warehouse floor.

table 2 Effect of transportation distances on feed pellet length

Transportation distance (km)	Percentage of pellet length ranges %				average
	3 -4 mm	5-6 mm	7- 8 mm	9-10 mm	
442	2.9	9.70	31.0	56.0	24.9
463	1.4	9.50	35.2	53.9	25
595	3.3	5.70	28.4	62.50	24.9

table 3 Comparison of the durability of pellets in the line feed field and the cylinder feed field

Sample location	Durability % of pellets in line feeding field	Durability % of pellets in the feed field without feed lines
1/3	84.2	73.52
2/3	86.2	76.32
3/3	92.4	73.89
MEAN	87.60	74.57
ERORR	2.75	

1\3 The first third of the length of the feed line (closest to the feed tank) , 2\3 The second third of the length of the feed line (the middle of the feed line), 3\3 The last third of the feed line length (farthest from the feed tank)

When comparing the arithmetic mean of pellet durability for three samples (beginning, middle, and end of the field) for a field where feed is provided to chickens using cylindrical feeders against a field where feed is provided using automatic feeding lines, an analysis of the results of the experiment shows that there is a significant difference between the averages of 74.57% and 87.60% in the field of traditional feeders. and automatic lines respectively. The durability of the pellets in the line field is better than the durability of the pellets in the traditional field after eating the feed for a week. We believe that the reason for the emergence of this result is due to poor management and handling of feed and its management in

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the traditional field and not to the behavior of the chickens, because the feed container in the two fields holds 10 chickens and the density of chickens inside the two fields is equal.

table 4 Comparison of the lengths of the pellets after feeding the feed in the cylinder feeder field and the automatic feeder field

Sample location	Pellet length ranges (mm)	Percentage of pellet length ranges in line feeding field (%)	Percentage of pellet length ranges in the feed field without feed lines (%)
1\3	3 - 4	8.14	1.96
	5 - 6	16.18	8.33
	7 - 8	23.5	32.1
	9 - 10	50	57.6
2\3	3 - 4	3.30	2.00
	5 - 6	5.90	9.10
	7 - 8	13.0	32.1
	9 - 10	77.9	57.8
3\3	3 - 4	5.95	2.03
	5 - 6	8.30	8.08
	7 - 8	33.30	32.12
	9 - 10	52.40	57.6
average	3- 10	24.82	25.06

The results in Table 4 show the comparison between the lengths of pellets in the feeding field using cylindrical feeders versus the automatic line feeding field. The results show that there are no significant differences between the lengths in the two fields in terms of the average length of 3 - 10 mm, as well as for the four length categories. This result proves that the behavior of pecking and feed intake was similar in the two fields and that the percentage of fine pellets less than 3 mm and dust was the result of poor feed management in the cylindrical feeding field and the likelihood of management using lines, the results of which appear in Table 3 .

4 - Conclusions

- There is an effect of the transportation distance from the factory to the field on the durability of the pellets, which does not exceed 2.5% if the distance exceeds 150 km.

- There is an effect of the transportation distance on the ability of the pellets to retain the length that was made in the factory, as they can retain 50% of the full length in the case of pellets with a strength of more than 97%.

- There is an effect of field management on chicken feeding methods on the durability of the pellets and an increase in undesirable ones (fine, less than 3 mm). The modern method of feeding (by lines) is superior to traditional methods.

- The locally made drop box device needs to be calibrated with a standard device, which is better than calibrating by comparing samples before and after transfer.

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