مجلة جامعة كركوك للعلوم الزراعية

Effect of die length, moisture content and particle size on some mechanical and physical properties of poultry feed pellets

Ahmed Sami Farha[1]
ahmed.farhan@su.edu.krd

Affan Othman Hussein[2]
affan@epu.edu.iq

[1] Department of Animal Resources, College of Agricultural Engineering Science, University of Salahaddin, Erbil, IRAQ.
[2] Department of Plant Protection, Khabat Technical Institute, Erbil Polytechnic University, Erbil, IRAQ.

- Date of research received 09/08/2023 and accepted 22/08/2023
- Part of M.Sc. Dissertation for the first author.

Abstract

This study investigates the role of manufacturing characteristics on some mechanical and physical properties of poultry feed pellets. laboratory study of 3 x 3 x 3 factorial experiment laid out to study the effect of die lengths (L1 = 3, L2 = 4, and L3 = 5) cm, moisture content of feedstuff (M1 = 12, M2 = 14 and M3 = 16) % and particle sizes (P1 = 0.5, P2 = 1 and P3 = 1.5) mm and their interactions on some physical and mechanical properties of poultry feed pellets. Pellet Durability Index (PDI), pellet hardness, bulk density of pellets and feedstuff, unit density of pellets, and power consumption were measured and evaluated. Results revealed that the interaction of longer die lengths, higher moisture content, and smaller particle size treatment ($L_3M_3P_1$) significantly increased the PDI (95.6%), hardness (6.4 Kg), and bulk density (683.97 Kg m^{-3}) when it compared with other treatments. Unit density increased with the treatment ($L_3M_2P_2$) when it compared with other treatments which it was 1453.29 Kg m^3. The highest power consumption of 4.51 Kwh^{-1} was recorded with the treatment ($L_3M_3P_3$) while the lowest value was for the treatment ($L_1M_1P_1$) and it was 3.07 Kwh^{-1} but statistically, there were no significant differences in power consumption between the treatments, the differences were only mathematically. According to the results obtained in this work, we can conclude that when using the long die path combined with high moisture content and fine feedstuff can produce better pellets which are physically and mechanically accepted by farmers.

Keywords: bulk density, pellets durability, pellets hardness, power consumption, pellets unit density

Citation: Farhan, A., & Hussein, A. (2023). Effect of die length, moisture content and particle size on some mechanical and physical properties of poultry feed pellets. *Kirkuk University Journal For Agricultural Sciences*,14 (3), 201-211. doi: 10.58928/ku23.14322

Correspondence Author: Ahmed Sami Farha - ahmed.farhan@su.edu.krd

Introduction

poultry agribusiness is an important agriculture sector in Kurdistan and it plays a crucial part in food production. The nutritional market is expected to expand in the next years as a result of human overpopulation, particularly in industrialized nations. Feeding is the most expensive part of poultry production, representing about 60 – 70 % of overall production costs [1]. Pelleting is the main thermal processing technique used for poultry feed production by agglomerate small particles of feed into larger particles. The feedstuff is subjected to pelleting after grinding, dosing, mixing and conditioning processes, high pressure, moisture, and temperature are used to agglomerate feedstuff particles altering its physical shape to pellets [2]. Furthermore, pellet as feed plays role in reducing eating time, increasing resting time and lowering maintenance energy and enhancing productive energy [3].

The feed pelleting process consists of many steps from the raw material till packing but the most three important steps are conditioning, pelleting, and cooling [4]. In the conditioning chamber water is added to the mash via direct steam injection, the steam not only improving the mash moisture, but also raises the mash temperature [5]. After conditioning the mash will face a pressure to die holes to formulate the pellets, die diameters ranging from 1 mm to more than 20 mm depending on the material or animal species [6]. Once pellets exit the pellet mill die, they are immediately exposed to cooler air to remove any excess heat and moisture [7], they explained that the pellet exit from the die at temperatures ranging from 80^{o}C to 90^{o}C then its temperature must be lowered to approximately 8°C above ambient.

Pellet quality in general refers to a feed pellet's ability to resist mechanical treatment without suffering significant breaking or fine formation [8,9]. High-quality pellets and low-quality pellets have different ratios of fines; a small ratio of fines indicates excellent-quality pellets, while a large ratio of fines indicates low-quality pellets [10]. Furthermore, some researchers [11,12,13] noted that the low physical quality pellets changed the feed intake pattern of broilers, negatively. Pellet quality is related to the factors of diet formula (40%), conditioning (20%), particle size (20%), die design (15%), and drying (5%) [14]. In addition, the pellet quality can be influenced by a number of parameters, including diet nutritional content, feed particle size, conditioning time and temperature, feedstuff moisture content, pressure rate of the pellet die, space between the roll and die of the pellet press [15]. According to [16], analyzed various factors influencing pellet quality in corn and soybean feeds, including particle size, thermal processing, moisture addition, and fat content. The study of Muramatsu found that thermal processing had the most significant impact, followed by moisture addition, fat content moderation, and finally, particle size reduction.

Pellets quality is associated with its physical and mechanical properties, the durability considers the most important characteristic of manufacturing pellets, high durable pellets limiting fragmentation and damage during bagging, handling and transporting [17,18]. Pellet Durability Index (PDI) is the most significant indicators for evaluating pellet quality and it represents the percentage of pellets that survive after applying mechanical forces [19].

The objective of the study is to find the best combination of die length, moisture content and particle size to produce pellets with high durability and less power consuming of the pelleting unit.

Material and Methods

The experiment was carried out at The Animal Resource Department Fields / College of agriculture engineering science / Salahaddin University-Erbil /Kurdistan Region - Iraq from 1st March 2022 to 17th July 2022 to study the effect of different die lengths, moisture content of feedstuff and particle size on some mechanical and physical properties the pellets made without binders. A factorial experiment of 3 × 3 × 3 based on a complete randomized design with three replicates was applied. The die lengths were (L_1=3cm, L_2=4cm and L_3=5 cm), moisture content (M_1=12%, M_2=14%, and $M_3$16%) and particle size (P_1=0.5mm, P_2=1.0mm and P_3=1.5 mm).

Material Preparation:

A total of twenty-seven kilograms (kg) of local corn (*Zea mays*), local wheat (*Triticum spp.*), and Argentine soybean (*Glycine max*) were prepared to produce broiler pellets. For each sample, the composition was 40%, 33%, 25%, and 2% of wheat, soybean, corn, and fat, respectively according to the commercial feed composition of Top Feed factory. These ingredients were ground in a hammer mill (KURTSAN model - made in Turkey) with a 4 mm screen size, powered by a 220V, 3 HP, 50 HZ electric motor, and operated at a rotational speed of 2800 rpm.

Moisture measurement and modification

Each sample was sieved and placed in a bag, prepared for moisture modification. This step primed the sample to proceed through the necessary stages for pellet production. The moisture content in the raw materials was ascertained in alignment with the ASABE standard applicable to unground grain and seeds [20].

$$MC=\frac{Ww-Wd}{Ww}\times 100 \quad \text{……….} (1)$$

Whereas:
MC = moisture content, (% w.b.)
Ww = weight of wet sample, (g)
Wd = weight after drying the sample, (g)

To get desired values of 12%, 14%, and 16% moisture content the samples were misted with a calculated amount of distilled water. Subsequently, they were meticulously mixed in a sealed plastic bag and stored in a refrigerator for a period of two days at a temperature of 5º C. The equation (2) provided by [21] was employed to discern the precise volume of water to be added to achieve the targeted moisture content in the samples.

$$Mw = \frac{mi\ (Mwf-Mwi)}{1-Mwf}\times 100 \quad \text{…….} (2)$$

Whereas:
Mw = mass of water should be added to the sample, g.
mi = initial mass of the sample, g
Mwf = final desired moisture content of the sample %.
Mwi = initial moisture content of the sample.

Particle Size distribution

A 100 grams sample was placed in sieves stack arranged vertically in a line (4, 3.5, 3, 2.5, 2, 1.5, 1, 0.5 and pan) mm and base from diameters largest to smallest. The sieve series was selected based on the range of particles in the sample. The duration of sieving is 10 minutes by FRITSCH sieve shaker. After that the amount of particles retained on each sieve weighted by an electronic scale with accurate of ± 0.1 g. Geometric mean diameter (Dgw) and geometric standard deviation (Sgw) of samples determined according to equations (3, 4 and 5) which formulated by standard ASABE [22].

$$D_{gw} = \log^{-1}\left[\frac{\sum_{i=1}^{n}(W_i \log \overline{di})}{\sum_{i=1}^{n} W_i}\right] \quad \text{……….. (3)}$$

$$S_{log} = \left[\frac{\sum_{i=1}^{n} W_i (\log \overline{di} - \log dgw)^2}{\sum_{i=1}^{n} W_i}\right]^{0.5} \quad \text{......... (4)}$$

$$S_{gw} = 0.5\ d_{gw}\ [\log^{-1} Slog^{-} (\log^{-1} S_{log})^{-1}] \quad \text{……… (5)}$$

Whereas:
d_i = diameter of sieve openings of the first sieve.
d_{i+1} = diameter of openings in next larger than previous sieve (just above in set).
$đ_i$ = geometric mean diameter of particles on i^{th} sieve $(di \times di+1)^{1/2}$.
W_i = weight fraction on the i^{th} sieve.
d_{gw} = geometric mean diameter.
Slog = geometric standard deviation of log-normal distribution by mass in ten-based logarithm, dimensionless
S_{gw} = geometric standard deviation of particle diameter by mass, mm.

Pelleting unit preparation and pellet making

A Chinese-made type 22 meat mincer was used in the experiment for feed pellet producing, some modifications were made to it according to the requirements of the experiment to simulate the reality of the process [23]. The meat mincer consists of the body, hopper, auger, internal cutting blade, cutting plate and the locking ring. The cutting plate which is responsible of extruding the material through it had been changed and 3 pelleting dies are replaced. the die lengths were (30mm, 40mm and 50mm) figure (1), each die contains 48 holes with a diameter of 5mm. External blades were attached to the auger shaft to cut the produced pellets according to the desired length. The device was driven by an electric motor. Feed mixtures were prepared for each treatment according to the research plan. The feed mixture was heated to a temperature of 70^{o}C by means of a steam generation device before being put to the device in a preparation for converting it into pellets. After heating, the feed mixture was placed in the device and the pellets were extruded from the die and cut by the external blade and placed screen plates, an air flow passed under the screen by mean of a fan to reduce the temperature and the moisture of the produced pellets. After cooling the measurements were done on the produced pellets as bellow:

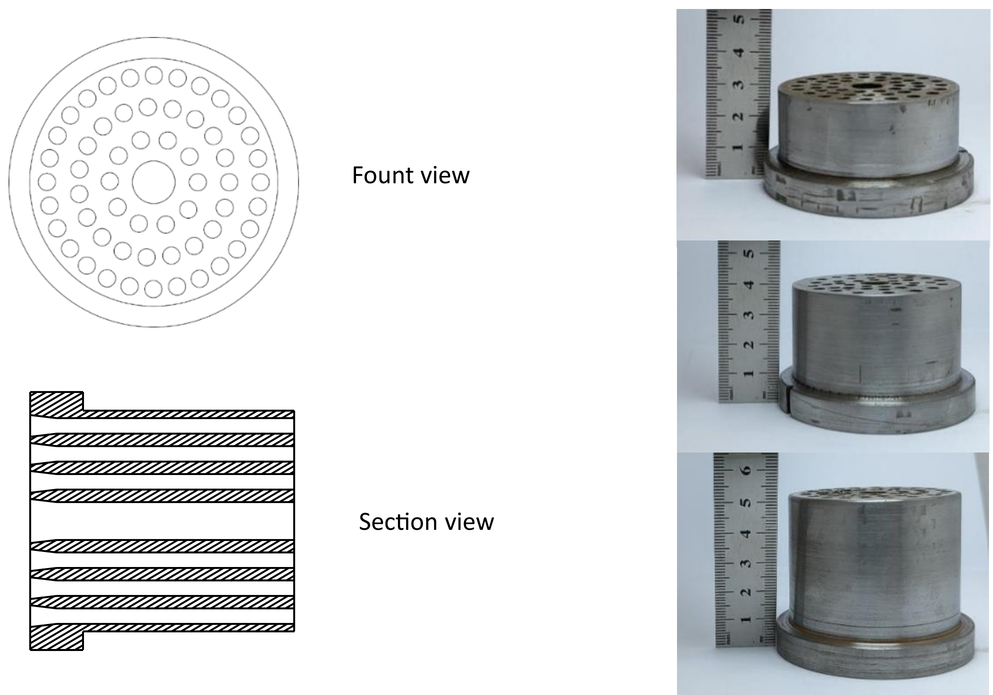


Figure 1. different die length, section view of the die, front view of the die.

Pellets Durability Index (PDI)

The method to determine the durability index of the pellets was calculated in this study based on the ASABE [24] standard method, which is designed to assess the pellets durability. A sample of 500 g of pellets to be tested (3 replicate) after eliminating fines and broken pellets by sieving through a 4 mm hole screen placed in tumbling box which proposed by the standard, the box dimensions were (300 × 300 × 240) mm with tight door, the samples were tumbled for 10 min at 50 RPM, the sample again screened to separate fine particles and retaining pellets which weighted by electronic scale. The PDI is calculated by dividing the weight of intact pellets by the total weight of pellets tested and multiplying by 100%, equation (6).

$$\text{PDI} = \frac{Mass\ of\ pellets\ after\ tumbling}{Mass\ of\ pellets\ before\ tumbling} \times 100 \quad \text{......... (6)}$$

Pellets hardness

The procedure for determining hardness involved randomly choosing about 20 pellets from each sample bag and then selecting 10 pellets in a descending order based on their length. The hardness testing methodology was executed using a Kahl durometer, a device featuring a manually operated pushing screw [25]. This screw was turned by hand at varying rates. Once the individual pellet samples had cooled, they were placed between two bars. Pressure was gradually increased via a spring, enabling the calculation of the force (measured in kilograms) required to fracture the pellets. Following this, the mean hardness value of these ten selected pellets was used as a representative hardness measure for the sample.

Pellets Bulk density

Bulk density of samples was measured using the grain bulk density apparatus according to ASABE standard [24]. The sample was placed on the funnel and pouring at the center of a known volume glass container continuously, since the sample was fluffy and did not flow down readily through the funnel, it was stirred using a thin rod in order to maintain a continuous flow of the material, the steel rod was moved over the top of the container in a zigzag style gradually leveling the container from the excess, then the mass of the samples inside the known container was weighed, five replicates were performed for each sample, the bulk density of the pellets calculated according to the equation (7) and expressed in $kg.m^{-3}$.

$$D = M / V \quad \text{……. (7)}$$

Whereas:

D = bulk density, $kg.m^{-3}$
M = mass, kg
V = volume, m^3

Pellets Unit density

Unit density represents to the weight of the pellet divided by its volume, considering only the solid part of the pellet and excluding any internal space or void between particles. This serves as an indicator of the pellet's compactness. According to Shanahan [26], the volume of each pellet can be estimated using equation (8). the unit density of the pellets was ascertained by a direct measuring technique using a digital vernier caliper to measure each pellet length and diameter, the volume of the pellets was estimated. Once the volume is measured, the pellets were weighted and the unit density calculated according to the equation (7), unit density is expressed in $kg.m^{-3}$ [24].

$$V = r^2 \times \pi \times h \quad \text{…… (8)}$$

Whereas:

V = volume of the pellet, mm^3
π = a mathematical constant approximately equal to 3.14159.
r = radius of the base of the pellet, mm.
h = the Length of the pellet, mm.

Power Consumption

The requisite power (in kilowatts) was calculated by noting down the voltage and current intensity. This was done using a digital clamp meter (Chinese made, Model KJ206A, featuring a measurement range of ~ 2A - 500A and 200V - 600V AC with an accuracy margin of ± 0.01). This device was used to measure the intensity of the line current (I) as well as the value of the potential difference (V). The electric power consumption was then deduced based on these measured values of current and voltage. The method employed for this estimation was derived from [27], as illustrated in the following equation (9):

$$Ep = \frac{I \times E \times PF \times 1.73}{1000} \quad \text{……. (9)}$$

Whereas:

Ep = electrical power, kW,
I = electric current, Amperes.
PF = Mechanical efficiency assumed to be 0.95 [28].
V= electrical voltage, V,

Experimental Design and Statistical Analysis

The experiment was designed and laid out using a factorial experiment based on a Completely Randomized Design (CRD). The treatments were arranged in a 3 × 3 × 3 factorial design, the factors were die length (3, 4, and 5 cm), particle size (0.5, 1.0, and 1.5

mm), and moisture content (12%, 14%, and 16%). All measurements were performed in triplicate to ensure accuracy and reproducibility. For data analysis the SPSS statistical software package [29] was used. The Least Significant Differences (LSD) test was used to compare the means of different treatments at a statistical significance probability of $P \leq 0.01$ level.

Results and Dissection

Geometric mean diameter of particles (dgw)

The geometric mean diameters of the feed stuff particles (Dgw) in different moisture contents are shown in the Fig (2). Generally, from the results obtained it can be noted that with increasing the moisture content of the all ingredients the geometric mean diameter of the particles is gradually increased, although there were significant differences between them, where is the wheat recorded the highest value of dgw for all moistures contents (12%, 14% and 16%) if it compared with corn and soybean meal, which they were (0.97, 0.99 and 1.13) mm, (0.70, 0.77 and 0.79) mm and (0.43, 0.52 and 0.52) mm respectively.

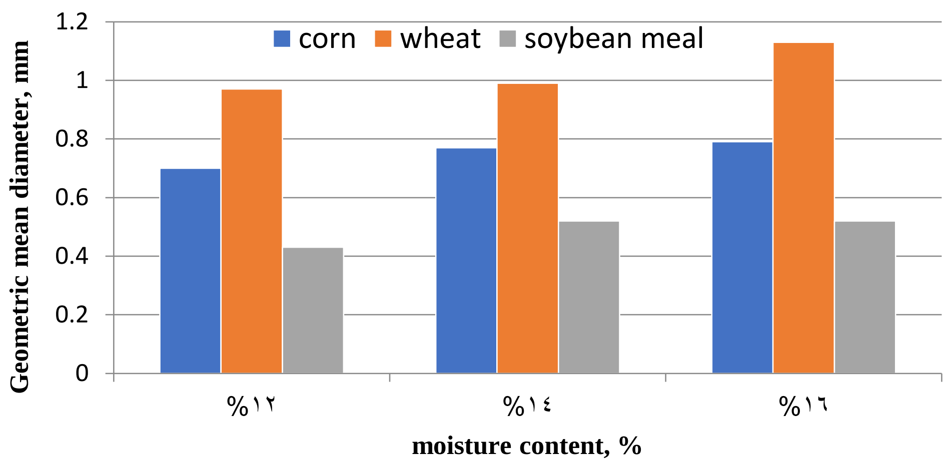


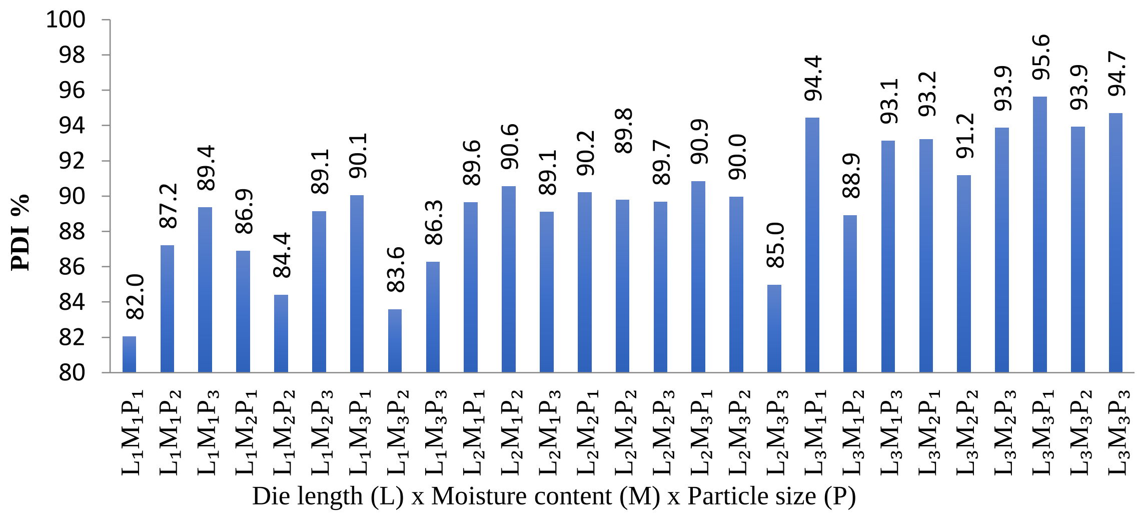
Figure 2. geometric mean diameter of feedstuff particles

Pellet durability index (PDI)

Effect of die length, moisture content of feed stuff and particle size on the durability of pellets production are shown in Fig.3. According to results obtained it seems that the PDI significantly increased gradually with increasing the die length, moisture content and particle size. The highest PDI recorded with the interaction of $L_3M_3P_1$while the lowest value was with treatment $L_1M_1P_1$ where the values were (95.6% and 82%) respectively, although $L_3M_3P_1$ statistically didn't show any differences with $L_3M_1P_1$ and $L_3M_3P_3$ where they were (95.6%, 94.4% and 94.7%) respectively, the differences were mathematically, but it showed significant difference when it compared with $L_3M_2P_1$ where it was 93.1%, that is mean that the main reason of the high PDI caused by the length of the die during of pellets production and it's refer to the best compaction of the ingredients crossing the die from the input to the output of the die, also the particle size playing role in increasing the PDI whereas the smaller particles gave the higher durable pellets because of the greater convergence and adhesion between the particles which leads to minimise voids between them and avoid creating weak points may lead to breakage of the pellets from it.

Pellets hardness

Effects of the die length, moisture content and particle size on the pellet's hardness are shown in the Fig.4. From the results obtained it seems that the pellets hardness increased with the same factors that the durability increased, that mean there is a positive relationship between the pellets hardness and durability, the higher the hardness, the greater the durability, but it is not applicable to the durable pellets to be hard pellets because of some binder ingredients which added to the feed mixture to enhance the pellets durability. The highest value of 6.4 Kg pellets hardness recorded with the interaction treatment of $L_3M_3P_1$ while the lowest value of 4.7 Kg was for both $L_1M_2P_2$, $L_1M_3P_3$ and $L_2M_1P_1$. All values obtained from this work for the pellet's hardness are within the acceptable rang, although the poultry nutritional researchers prefer the moderate hard pellets with high durability



.

Figure 3. Effect of die length, moisture content and particle size on pellets durability.

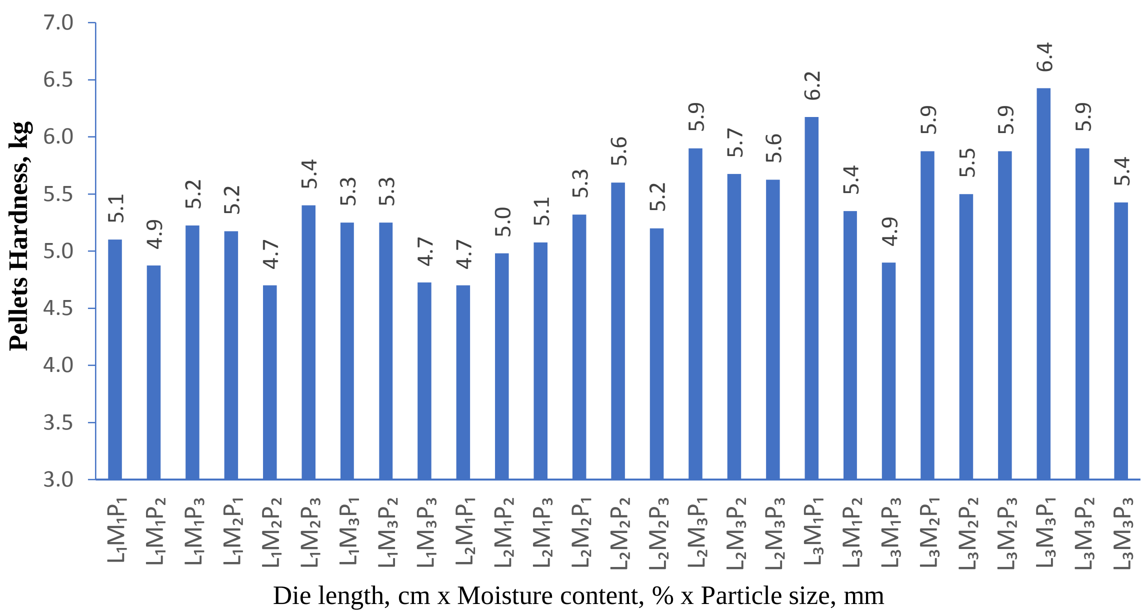


Figure 4. Effect of die length, moisture content and particle size on pellets hardness.

Pellets bulk density

Figure 5. shows the effect of die length, moisture content and particle size on the pellets bulk density. There were significant differences between the treatments, from the interaction of die length, particle size, and moisture on pellet bulk density, it is evident that the highest result was achieved with the combination of $L_3P_1M_3$. Specifically, using a die length of 5 cm, particle size of 0.5 mm, and moisture content of 16% resulted in a high value of 683.97 Kg m^{-3}. On the other hand, the lowest value was 624.5 Kg m^{-3} observed when using a die length of 3 cm, particle size of 1.0 mm, and moisture content of 12%. The bulk density is an indicator for good compacted pellets, because it depending on the weight of pellets in a volume unit, that means whenever the compacting process of the pellets be high the weight will be higher in the same volume and conscionably produce better pellet bulk density which is suitable for storing.

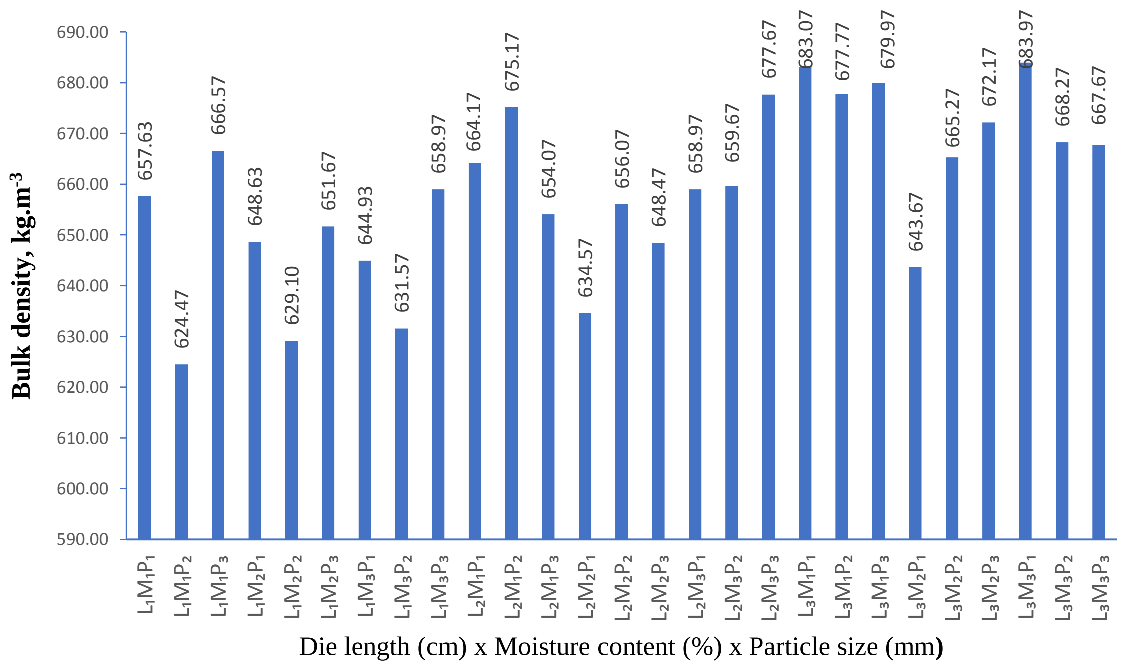


Figure 5. Effect of die length, moisture content and particle size on the of pellets bulk density.

Unit density of pellets

Effect of die length, moisture content and particle size on unit density is illustrated in the figure 6. From the results it can be observed that the unit density affected by the same factors which affected the other parameters of this study. The highest value was recorded for the interaction treatment of $L_3M_2P_2$ while the lowest value was for the combination of $L_1M_1P_1$ and they were (1453.29 and 1214.17) kg.m^{-3} respectively. Although there are variability between the pellets bulk density values and pellets unit density values that is the differences between the treatments in the bulk density is not so big to be considerable but for the unit density the differences appear bigger between them, the reason refers to the non-uniformity of the pellet length during measuring process for bulk density which leads to have voids between the pellets, while for the unit density this phenomena will not appear because of the regulating of each pellet for measuring.

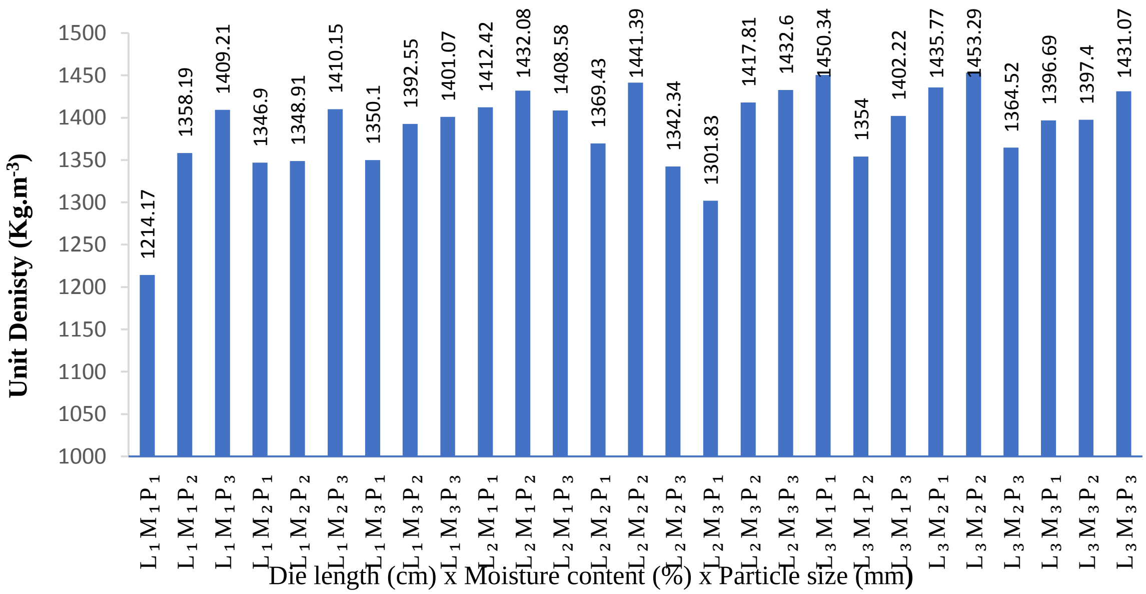


Figure 6. Effect of die length, moisture content and particle size on pellets unit density.

Power consumption

Figure 7. showing the effect of the die length, moisture content and particle size on the pelletizer machines power consumption. Generally, there were no any statistical differences between the treatments in the power consumption, the differences were only mathematically. However, the power consumption value increased gradually with increasing the die length, moisture content and particle size, the lowest value of 3.07 Kw was recorded with the treatment of $L_1M_1P_1$while the highest value of 4.51 Kw was with treatment $L_3M_3P_3$.

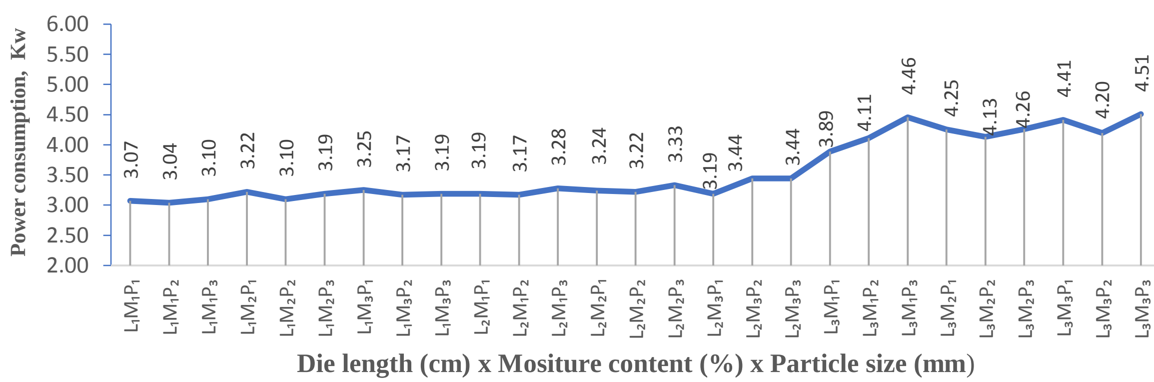


Figure 7. Effect of die length, moisture content and particle size on power consumption

Conclusions

From the results obtained in this study we can conclude that the pellets durability which considers the important factor for good quality of pellets affected by the combination of the die length, moisture content and particle size, the higher durability achieved with the longer die path 5cm, higher moisture content of feedstuff 16% and smaller particle size 0.5mm. Also, the pellets hardness falls under the same factors that the durability affected with, as well the bulk and unit density of the pellets. Power consumption of the pelletizing unit didn't affect significantly by increasing the study treatment units, that means for manufacturing a good pellet with high quality of mechanical and physical properties and lower consuming power the best selection will be $L_3M_3P_1$.

References

[1] Khdr, N.E., Ismael, T.E. and Mohamed, F.S., 2019. Effects of commercial pellet and mash feed on performance of broiler chickens.

[2] Amerah, A.M., Gilbert, C., Simmins, P.H. and Ravindran, V., 2011. Influence of feed processing on the efficacy of exogenous enzymes in broiler diets. *World's Poultry Science Journal*, *67*(1), pp.29-46.

[3] McKinney, L.J. and Teeter, R.G., 2004. Predicting effective caloric value of nonnutritive factors: I. Pellet quality and II. Prediction of consequential formulation dead zones. Poultry Science, 83(7), pp.1165-1174.

[4] Thomas, M. and van der Poel, A.F.B., 2020. Fundamental factors in feed manufacturing: Towards a unifying conditioning/pelleting framework. *Animal Feed Science and Technology*, *268*, p.114612.

[5] Briggs, J.L., Maier, D.E., Watkins, B.A. and Behnke, K.C., 1999. Effect of ingredients and processing parameters on pellet quality. *Poultry science*, *78*(10), pp.1464-1471.

[6] Ziggers, D., 2003. Die determines pellet production. *Feed Tech*, *7*(8), pp.17-9.

[7] Zimonja, O., Stevnebø, A. and Svihus, B., 2007. Nutritional value of diets for broiler chickens as affected by fat source, amylose level and diet processing. *Canadian Journal of Animal Science*, *87*(4), pp.553-562.

[8] Muramatsu, K., Massuquetto, A., Dahlke, F. and Maiorka, A., 2015. Factors that affect pellet quality: a review. *Journal of Agricultural Science and Technology*, *9*(2), pp.717-722.

[9] Behnke, K.C. and Gilpin, A., 2014. Principles of mash conditioning. Feed Pelleting Reference Guide. Kansas State University, Manhattan, Kansas, USA.

[10] Svihus, B., (2009). Lecture notes Grinding, HFE 305 course, NMBU Department of Animal and Aquacultural Sciences.

[11] Quentin, M., Bouvarel, I. and Picard, M., 2004. Short-and long-term effects of feed form on fast-and slow-growing broilers. *Journal of Applied Poultry Research*, 13(4), pp.540-548.

[12] Corzo, A., Mejia, L. and Loar II, R.E., 2011. Effect of pellet quality on various broiler production parameters. *Journal of Applied Poultry Research*, *20*(1), pp.68-74.

[13] Lilly, K.G.S., Gehring, C.K., Beaman, K.R., Turk, P.J., Sperow, M. and Moritz, J.S., 2011. Examining the relationships between pellet quality, broiler performance, and bird sex. *Journal of Applied Poultry Research*, *20*(2), pp.231-239.

[14] Reimer, L., 1992. Northern Crops Institute feed mill management and feed manufacturing technology short course. *California Pellet Mill Co.: Crawfordsville, IN*.

[15] Čolović, R., Vukmirović, Đ., Matulaitis, R., Bliznikas, S., Uchockis, V., Juškienė, V. and Lević, J., 2010. Effect of die channel press way length on physical quality of pelleted cattle feed. *Food and feed research. Novi Sad: Institute for Food Technology (FINS), 2010, Vol. 37, iss. 1*.

[16] Muramatsu, K., 2013. *Predictive Modeling Application in Pelleting Process of the Feed for Broilers* (Doctoral dissertation, Ph. D. thesis, Universidade Federal do Paraná, Curitiba).

[17] Mina-Boac, J., Maghirang, R.G. and Casada, M.E., 2006. Durability and breakage of feed pellets during repeated elevator handling. In *2006 ASAE Annual Meeting* (p. 1). American Society of Agricultural and Biological Engineers.

[18] Lowe, R., 2005. Judging pellet stability as part of pellet quality. *AFMA Matrix (South Africa)*.

[19] Salama, A., Tawfik, M.A. and Abd-Elaal, M.M., 2021. PERFORMANCE EVALUATION OF A NOVEL DESIGN OF FEED PELLETS VERTICAL COOLER. *Zagazig Journal of Agricultural Research*, *48*(3), pp.729-745.

[20] ASABE., 2017. Moisture Measurement-Unground Grain and Seeds. American Society of Agricultural Engineers, St Joseph, MI, USA.

[21] Shaw, M. and Tabil, L., 2006. Mechanical properties of selected biomass grinds. In *2006 ASAE Annual Meeting* (p. 1). American Society of Agricultural and Biological Engineers.

[22] ASABE., 2017. Method of determining and expressing fineness of feed materials by sieving. ASABE, St. Joseph, MI. USA.

[23] Olugboji O.A., M.S. Abolarin, M.O. Owolewa, K.C. Ajani, 2015. Design, Construction and Testing of a Poultry Feed Pellet Machine. *International Journal of Engineering Trends and Technology (IJETT)*. Volume 22, Number 4. 168-172.

[24] ASABE., 2016. Wafers, pellets, crumbles-definitions and methods for determining density, durability, and moisture content. American Society of Agricultural Engineers, St Joseph, MI, USA.

[25] Thomas, M.A.F.B. and Van der Poel, A.F.B., 1996. Physical quality of pelleted animal feed 1. Criteria for pellet quality. *Animal feed science and technology*, *61*(1-4), pp.89-112.

[26] Shanahan, C. 2016. The relationship between the volume of a cylinder and its height and radius. Project Maths. http://www.projectmaths.ie/documents/MathsCounts2016/RelationshipsInACylinder.pdf.

[27] Evans, C.E., Saensukjaroenphon, M., Gebhardt, J.T., Stark, C.R. and Paulk, C.B., 2021. Effects of conditioning temperature and pellet mill die speed on pellet quality and relative stabilities of phytase and xylanase. *Translational Animal Science*, *5*(3), p. txab043.

[28] Metwally KA (2010) Study the effect of some operational Factors on hammer mill.

[29] SPSS (2011). Statistical Packages for the Social Sciences, 20th edn., IBM Inc, Chicago, USA.

مجلة جامعة كركوك للعلوم الزراعية

تأثير طول القالب ومحتوى رطوبة المواد العلفية وحجم الجسيمات في بعض الخواص الفيزيائية والميكانيكية لاقراص علف الدواجن

أحمد سامي فرحان[1]
krdahmed.farhan@su.edu.

عفان عثمان حسين[2]
affan@epu.edu.iq

[1] قسم الثروة الحيوانية، كلية هندسة وعلوم الزراعية، جامعة صلاح الدين– أربيل، العراق

[2] قسم وقاية النبات ، المعهد التقني في خبات، جامعة أربيل التقنية – أربيل ، العراق.

- تاريخ استلام البحث 09/08/2023 وتاريخ قبوله 22/08/2023
- البحث مستل من رسالة ماجستير للباحث الاول

الملخص

تبحث هذه الدراسة عن الدور الذي تلعبه بعض خصائص التصنيع في بعض الصفات الميكانيكية و الفيزيائية لاقراص أعلاف الدواجن. تم إجراء تجربة عاملية مختبرية بثلاثة عوامل باستخدام التصميم العشوائي الكامل (CRD) لدراسة تأثير أطوال القوالب (L_1 = 3, L_2 = 4 and L_3 = 5) سم ، ومحتوى الرطوبة في المواد العلفية %(M_1 = 12, M_2 = 14 and M_3 = 16) و درجة جرش و نعومة المواد العلفية المجروشة(P_1 = 0.5, P_2 = 1 and P_3 = 1.5) مم تداخلاتها في بعض الخصائص الميكانيكية و الفيزيائية لاقراص أعلاف الدواجن. تم قياس وتقييم مؤشر متانة الاقراص (PDI)، صلابة الاقراص، كثافة الكلية للاقراص العلفية، كثافة الوحدة للاقراص واستهلاك الطاقة لوحدة التصنيع. تبينت النتائج بان طول القالب (5 سم) وحجم الجرش (0,5 ملم) ومحتوى الرطوبة (16%) زاد بشكل ملحوظ من متانة الحبيبات بنسبة 95,6 %، وصلابة الحبيبات التي كانت 6,4 كغم قوة وكثافة الاقراص التي كانت 683,97 كجم م3 عندما تمت مقارنتها مع المعاملات الأخرى. في حين زادت كثافة الوحدة للاقراص مع المعاملة ($L_3M_2P_2$) عندما تمت مقارنتها مع المعاملات الأخرى والتي كانت 1453,29 كجم.م–3. سُجل أعلى استهلاك للطاقة 4,51 كيلوواط مع المعاملة ($L_3M_3P_3$) بينما كانت القيمة الأدنى للمعاملة ($L_1M_1P_1$) وكانت 3,07 كيلوواط. وفقًا للنتائج التي تم الحصول عليها في هذا الدراسة، يمكننا الاستنتاج أنه عند استخدام القالب الطويل مع الرطوبة العالية واحجام حبيبات صغيرة يمكن أن ينتج حبيبات بمتانة وجودة افضل و بصفات ميكانيكية و فيزياوية مقبولة للمزارعين.

الكلمات المفتاحية : الكثافة الكلية، متانة الاقراص، صلابة الحبيبات، استهلاك الطاقة، كثافة الوحدة.