# ENGINEERING STUDIES IN INTENSIVE POULTRY PRODUCTION

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## ABSTRACT

*The mechanization become as a basic input in all the facilities, stages and fields of the agricultural production which included the intensive poultry production, and as a basic step to design or develop any facility; the production analysis & study must be done. Therefore, the important physical engineering properties and the specification of the poultry must be studies which connect and affect on any used mechanical method which deals with that alive movable product. So, an experiment design made to study some important physical engineering properties for intensive birds under our local conditions in the Poultry farm in our faculty of agric. / Cairo university for three production cycle from September to December – 2009 and study the link and the effect of that properties on some other parameters which are considered as engineering base when there is any arrangement with the alive intensive poultry with using any mechanical tools. The experiment random sample consisted of 300 birds (Arbarecars – type1+) divided into 3 iterations, information on body weight and 9 body measurements was individually collected from all chickens sample and by using* ***(M Stat.)*** *package to analysis the data; the targeted statistical parameters and measurements was indicated beside some other information. Also, three principal external indices were calculated (in %) the Stockiness, the Massiveness and the Long-leggedness. As a final point, indicate the value of the major 3 axis (**X – Y – Z**) for the sample and calculate the maximum bird space volume. Finally the important obtained results were as follow:*

- *The maximum bird space volume was (0.11 $m^3$) depending on the max values for each sample space axis.*
- *The massiveness index gives ratio (1:5.8); the stockiness index gives ratio (1:1.3) and the long-leggedness index gives ratio (1:0.23).*

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- *The statistical analysis shows correlation with highly significant degree between most of the body measurements.*
- *The following prediction equations can be used to calculate the important and targeted body measurements which have highly correlation and significant:*

***Total body width = - 7.484 + 0.029 Body weight***
***Stretching body height = + 5.669 + 0.017 Body weight***
***Body length = - 2.957 + 0.019 Body weight***
***Breast circumference = + 0.58 + 0.021 Body weight***

## INTRODUCTION

The mechanization become as a basic input in all the facilities, stages and fields of the agricultural production which included the intensive poultry production, consequently the mechanization inter to complete a lot of regular practices and main operations like feeding, drinking, feed production, cooling, heat control and ventilation……etc. Also the mechanization beat some irregular practices such as a lot of use of robot, remote automatic control, litter formation for new breeding birds and the poultry harvesting or clearance from its houses and doing the related processes such as weight, separation, grading and finally the filling process.

As a basic step to design or develop any facility; the production analysis & study must be done and the following chart (fig. 1) show the machine development steps and procedures which must be followed and study **(Nasr, 2008)**.

Therefore, the important physical engineering properties and the specification of the poultry must be studies under our local situation which connect and affect on any used mechanical method which deals with that alive movable product. So, the aim of the recent study is as follows:

**Study some physical engineering properties for the intensive birds under our local conditions which are the product that deals with the mechanical technologies and systems.**

**Also, the target can be divided as follows:**

1. Design an experiment to study some of the important physical engineering properties for intensive birds to achieve values for the important statistical parameters and the prediction equations which link those properties.
2. Calculate the principal external indices for birds under the study.
3. Indicate the value of the 3 major axis for birds and the maximum bird space volume.

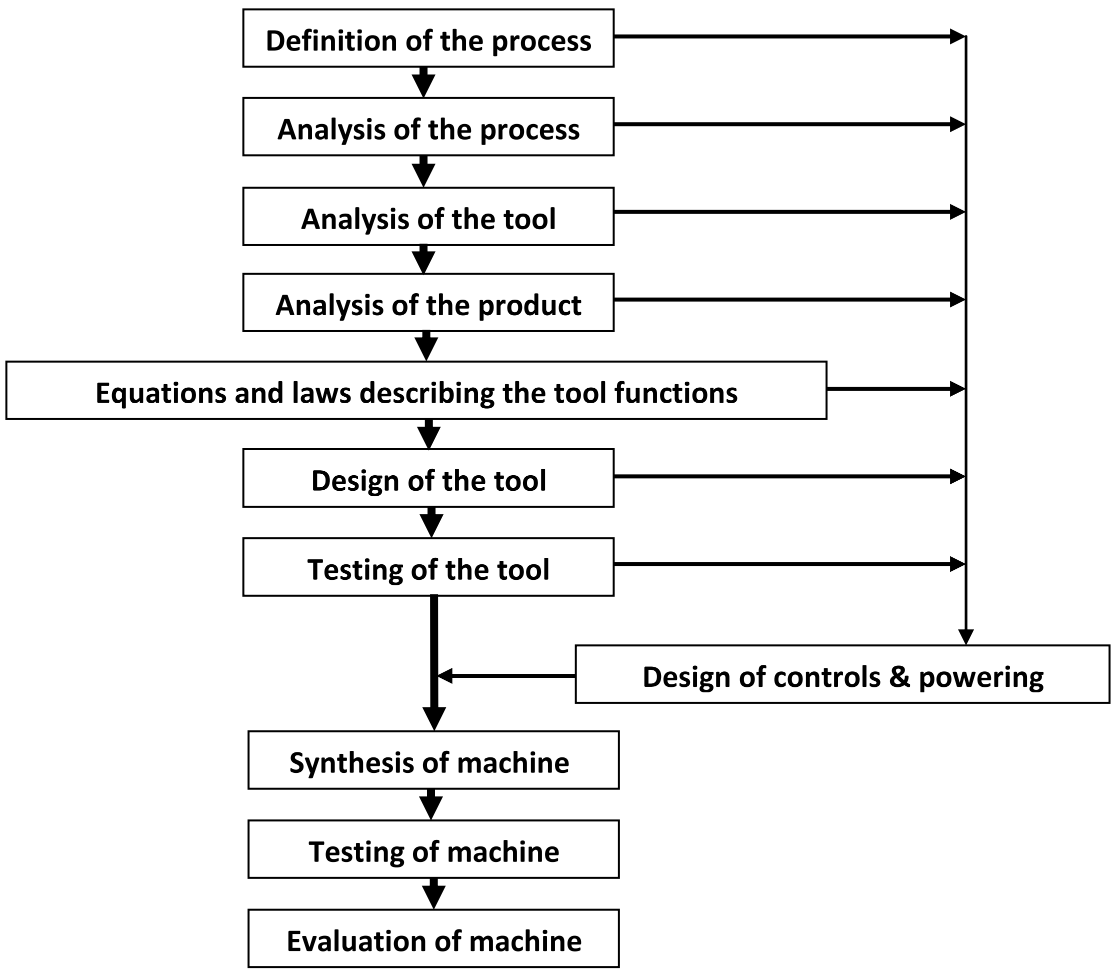


**Fig. 1. The development procedure**

To introduce homogenous meat chickens to the birds slaughterhouses **(Abdel Aziz, 2002)** made a separation for habard birds at 21 days old to three weighted grade (light, medium and heavy) beside the mixed group and the important results were the significant increase for the eatable parts percentage for the heavy group in comparison to the mixing group and finally the study recommended that the meet chicken must be divided at three weeks old to three weighted groups to achieve a homogenous bulk sent to the automatic slaughterhouses. Also in another study he mentioned that the increase of the birds density leads to disadvantage in the slaughtered birds so that the quality decrease and the bad birds percent with density of (12 bird/$m^2$) was 35 % in winter and 42 % in the summer.

**(Keeling and Duncan, 1991)** observed the use of space by a group of medium hybrid and bantam hens in a large enclosure. They found that the medium hybrid hens chose to space furthest away from the hen closest to them when they were walking (35 in), and more closely when ground pecking (18 in), standing (10 in), and preening (5.5 in). The distances that bantams maintained between themselves during these same activities were generally smaller (10.8, 12.5, 10 and 4.3 in, respectively).

About the dimensions of livestock and poultry **(ASAE, 2006)** mentioned that the purpose of these Data is to provide information for use in the design of buildings and equipment for livestock and poultry. Summaries of available Information are presented in the form of tables and curves of weight versus age and physical dimensions versus weight for various classes of livestock and poultry.

1. **Poultry Weight:** The weight of several strains of broilers versus age is shown in a figures form. Also a growth curve for an improved commercial broiler strain is available.
2. **Poultry Dimensions:** The standing height and the sitting height versus weight of commercial broilers are shown in **Fig. 2**. The heights were measured vertically from the floor to the highest Point along the proposal region, with the chickens standing and sitting with their heels resting on the floor.
   - For standing chickens, $\mathbf{H_1 = 22.58\ WT^{0.3236}}$ **…….Eq. 1.**
   - **F**or sitting chickens, $\mathbf{H_2 = 10.26\ WT^{0.3152}}$ **…….Eq. 2.**

   Where: WT = weight in gram, H1= standing height and H2 = sitting height in mm.

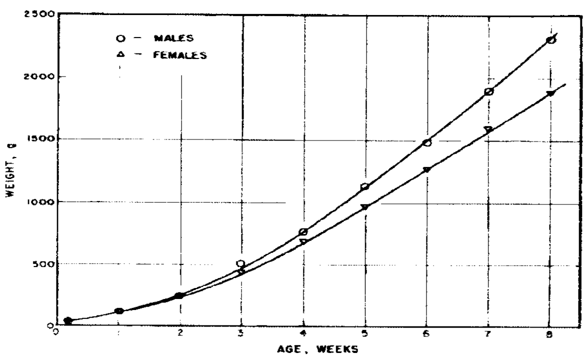


**Figure 2. Weight versus age of broilers**

**Guèye, et al., 1998)** investigated the possibilities of using body measurements to predict the body weight of mature Senegalese indigenous chickens with high level of accuracy. The General Linear Models Procedure was applied to the body weight and body measurements, and to calculate least square means. The following statistical model was used:

$$\mathbf{Y_{ij} = \mu + S_i + e_{ij}} \text{ ……………… } \mathbf{Eq.\ 3.}$$

Where, $\mathbf{Y_{ij}}$ **=** estimated value for the body weight or body measurement; $\boldsymbol{\mu}$ **=** population mean (mean that would exist if all classes had equal numbers); $\mathbf{S_i}$ **=** fixed effect of sex; $\mathbf{e_{ij}}$ **=** residual error.

Pearson's correlation coefficients were estimated between body weight (BW) and all body measurements. Data were subject to linear and multiple regressions for predicting BW. The prediction equations for body weight (BW, g) on the basis of body length (BL, cm) or/and circumference of chest (CC, cm) was as follow:

| **Sex** | **Regression equations** | **Eq. No** | **Sig.** |
|---|---|---|---|
| Male | BW = - 1653 + 74.0 BL | Eq. 4. | *** |
| Male | BW = - 899 + 80.2 CC | Eq. 5. | *** |
| Male | BW = - 2138 + 45.4 BL + 58.4 CC | Eq. 6. | *** |
| Female | BW = - 346 + 38.8 BL | Eq. 7. | ** |
| Female | BW = - 1230 + 91.3 CC | Eq. 8. | *** |
| Female | BW = - 1747 + 17.2 BL + 86.1 CC | Eq. 9. | *** |

** = P<0.01; *** = P<0.001

Finally, **(Guèye, et al., 1998)** concluded that results, obtained from 502 males and 325 females, revealed that more males (60.7 %) were removed from fowl flocks for sale and males showed higher body weights and body measurements (P<0.001).

Correlation coefficients between the body weight and the circumference of chest were strong and high (P<0.001 in males as well as in females). The body weight was also correlated to the body length (P<0.001 in males and P<0.01 in females). Thus, the circumference of chest and the body length are the body measurements that are most suitable for the prediction of the body weight.

**(Olawunmi, et al., 2008)** mentioned that by using a 20 kg-weighing instrument and a measuring tape, live-weight and 11 body parameters were taken on 101 Yoruba comprising 52 males and 59 females and 51 Fulani ecotype chicken consisting of 46 males and 5 females. The monitored variables include comb length (CL), beak length (BEL), head length (HL), neck length (NL), body length (BL), wing length (WL), shank length (SL), thigh length (THL), and toe length (TL). Others were breast length (BRL), breast breadth (BRB) and live weight (W). With the help of a field assistant, the birds were each time held in comfortable position and measurements taken in particular order many times for accuracy. Taking the live weight after body measurements for each bird produced more reliable weight score since the birds were then more settled.

**Statistical Analysis:** Least square means, standard deviation (SD), standard error (SE) and coefficient of variation (CV %) for each body parameters monitored were computed using the SAS (1999) package. These were split on the basis of sex and genotype. T-statistic procedure of the same package was used to detect the significance of the difference between the classes prescribed.

Finally, **(Olawunmi, et al., 2008)** concluded that the aim was to provide baseline information on size characteristics of Fulani and Yoruba ecotype chickens, differentiate between the types and use the morphometrical variables for a preliminary assessment of type and function. Results showed that least square means of live weight, wing and shank length, body, thigh and toe length, beak length and breast breadth of the Fulani ecotype were generally higher ($P < 0.01$) than those of the Yoruba ecotype. The males were also superior ($P < 0.01$) to the females for comb, wing, shank length and breast breadth while live weight, toe and thigh length also differ ($P< 0.05$) within each ecotype. The comb of males was more prominent than those of the females. Coefficients of variation were very small signifying a monotypic condition and an almost equal opportunity of selection for type based on body parameters of the two ecotype chickens. The Fulani ecotype was bigger than the Yoruba ecotype chicken. The significantly longer ($p<0.05$) bodies of the Fulani suggests a departure in function between the genotypes. The Fulani chickens appear more closely suited for egg production than the Yoruba type. Their potential for developing a more adapted commercial stock and genetic improvement of the chickens for the region and other implications of type on function are discussed.

**(Goliomytis, et al., 2003)** concluded that as no differences were observed between the two strains, for any of the traits measured, the statistical analysis was made using pooled data. Growth curves for BW, breast weight, and leg weight were calculated. The Richards function was chosen to fit the data. The type of the curves predicted was typically sigmoid. Asymptotic weights for BW, breast weight, and leg weight were estimated at 6,870.2, 1,744.2, and 851.5 g, respectively. Age at point of inflection, at which maximum growth rate is attained, was predicted at 44.4, 47, and 49.1 d, respectively. The percentage of breast and breast meat increased with age, whereas percentages of leg, thigh, and drumstick remained roughly constant.

About the weight development and body configuration of turkey-broiler parents' BIG-6 **(Oblakova, 2007)** mentioned that the parameters characterizing the meat production traits of turkeys are some exterior indices: body length, breast circumference, keel length, breast depth and total leg length. The body conformation type and the meatiness of turkeys could be better expressed via the massiveness index, the stockiness index and the long-leggedness index. They state the ratio of measurements that characterize the proportionality of bird's body **(Ivanov, et al., 1998, Donchev, et al., 1991)**. **(Nestor, 2001/2005)** studied the body shape, the growth and the various body measurements of several lines of turkeys. And **(Lalev, 2001)** published data about the regular growth rate in all body parts up to the age of 6 months, preserving equal proportions with exception of breast circumferences, in BUT 9 gobblers.

**(Oblakova, 2006)** communicated insignificant differences in leg measurements in five lines of turkeys aged 20 weeks. Also he aimed to determination of the live body weight of turkeys at the age of 4-20 weeks, determination of some value quantitative exterior traits that influence the conformation of the body and determination of principal selection indexes: stockiness, massiveness, longleggedness.

Thirty male turkeys, Turkey parents BIG 6, from British United Turkey limited, aged 4-20 weeks, were used. In order to establish the phenotype characteristics of BIG 6, measurements of 9 exterior body parameters were performed with a precision of 1 cm: body length, breast circumference (with a band), breast width and depth (with calipers), keel length, shank length, femur length, metatarsal length, total leg length (with a band). The live body weight was determined with a precision of 10 g.

Three principal exterior indices were calculated (in %): stockiness (the ratio of breast circumference to body length × 100), massiveness (the ratio of live body weight to body length × 100) and long-leggedness (the ratio of leg length and body length × 100).

Finally, **(Oblakova, 2006)** concluded that the body conformation type and the meatiness of turkeys could be better expressed via the massiveness index, the stockiness index and the long-leggedness index. The live body weight and the quantitative exterior traits that influence the conformation of the body were measured. Other principal selection indexes, stockiness, massiveness, and long-leggedness were measured.

The data allowed us to make some principal conclusions about the growth and development of growing turkey poults from the BIG- 6 on the basis of the live body weight and the exterior traits:

1. Male turkeys parents BIG 6 reached a live body weight of 14.9 kg ($p < 0.001$) at the age of 20 weeks.
2. The growth intensity was the highest between the 6th and the 8th weeks, when the turkey-broilers increased their live

body weight by 52% and 55% respectively, and this trend was maintained up to the 14th weeks of life.

3. The nine body measurements increased consistently during the entire period; by the end of the period, the most intensive growth was that of breast circumference: by 140%, followed by breast width by 130% and keel length by 119%.
4. By the age of 20 weeks turkey poults from the BIG 6 had a stockiness index of 129.30% and massiveness index of 31.87% − traits for solidity of the body and clearly defined traits for meat-type turkeys.
5. The Male turkeys parents BIG 6 could be placed as sire side in the hybridization scheme for the production of the final product – turkey broiler.

## MATERIAL AND METHODS

As mentioned before the recent study goals are to study some physical engineering properties for birds which are the product that deals with any mechanical technologies and systems. So, the important physical engineering properties and the specification of the poultry must be studies under our local situation which connect and affect on any used mechanical method which deals with that alive movable product.

To get that target; an experiment design made to study some important physical engineering properties for intensive birds under our local conditions in the Poultry farm in our faculty of agric. / Cairo university for three production cycle from September to December – 2009 and study the link and the effect of that properties on some other parameters which are considered as engineering base when there is any arrangement with the alive intensive poultry with using any mechanical tools.

The experiment random sample consisted of 300 birds (Arbarecars – type1+) divided to 100 birds into 3 iterations and by using a weighing instrument and a measuring tape, information on body weight and 9 body measurements was individually collected from all chickens sample. The measurements included body weight (W), body length (BL), leg length (LL), body height (BH), stretching body height (SBH), body width

(BW), total body width (TBW), breast circumference (BC), relax standing height (RSH) and sitting height (SH).

**Statistical Analysis goals:**

- Min and Max beside mode, Least square means, standard deviation (SD), standard error (SE) and coefficient of variation (CV %) for each body parameters monitored were computed using the (M stat.) package, Correlation coefficients between all the measurements and significant test and simple regression to achieve the prediction equations for the important and highly significant correlated measurements.

Also, three principal external indices were calculated (in %):

- Stockiness; (the ratio of breast circumference to body length × 100).

  ***St. = ( BC / BL )× 100 …………….. Eq. 10.***

- Massiveness; (the ratio of live body weight to body length × 100).

  ***Ma. = ( W / BL )× 100 ……….….. Eq. 11.***

- Long-leggedness; (the ratio of leg length and body length × 100).

  ***Lo.L. = ( LL / BL )× 100 ……….. Eq. 12.***

As a final point, indicate the value of the major 3 axis (**X – Y – Z**) for our farm birds and calculate the maximum bird space volume.

Finally, from this experiment a vision about the physical engineering properties can be established and a scientific engineering concept can be created to support any mechanical tool design which deals with those birds.

## RESULTS AND DISCUSSION

**Table (1)** shows the targeted statistical parameters and measurements.

**Table (1) The targeted statistical parameters and measurements.**

| **The parameter** | W | **BL** | LL | BH | **SBH** | BW | **TBW** | BC | RSH | SH |
|---|---|---|---|---|---|---|---|---|---|---|
| | gr. | cm | cm | cm | cm | cm | cm | cm | cm | cm |
| **Min** | 1568 | 31 | 6 | 12 | 36 | 12 | 40 | 36 | 21 | 12 |
| **Max** | 2608 | 41 | 11 | 26 | 46 | 24 | 59 | 49 | 33 | 18 |
| **Mean** | 2007,21 | 34,42 | 7,87 | 18,29 | 40,38 | 17,41 | 51,12 | 43,46 | 28,84 | 14,71 |
| **SD** | 208,61 | 2,17 | 0,91 | 2,21 | 2,10 | 2,53 | 2,76 | 2,25 | 2,50 | 1,25 |
| **SE** | 12,04 | 0,13 | 0,05 | 0,13 | 0,12 | 0,15 | 0,16 | 0,13 | 0,14 | 0,07 |
| **CV%** | 10,39 | 6,31 | 11,62 | 12,08 | 5,21 | 14,56 | 5,39 | 5,17 | 8,66 | 8,52 |
| **Mode** | 1990 | 35 | 8 | 19 | 40 | 17 | 50 | 44 | 30 | 15 |

- **The main bird space axis (X – Y – Z) and the maximum bird space volume:**

**Table (2)** shows the important statistical parameters which define the bird space axis (x-y-z) and the bird space volume.

**Table (2) The main bird space axis (X – Y – Z) and the maximum bird space volume.**

| The parameter | X | Y | Z | V | |
|---|---|---|---|---|---|
| | Total body width (cm) | Stretching body height (cm) | Body length (cm) | Space volume ($cm^3$) | Space volume ($m^3$) |
| **Mean** | 51,12 | 40,38 | 34,42 | 71050,645 | 0,071 |
| **Max** | 59 | 46 | 41 | 111274 | 0,111 |
| **Min** | 40 | 36 | 31 | 44640 | 0,045 |
| **Mode** | 50 | 40 | 35 | 70000 | 0,07 |

By using the data of table (2) it can be realized to the follows:

- The average value for the sample bird total body width (x axis) is (51.12 cm) with max value (59 cm) and min value (40 cm) and the mode value is (50 cm).
- The average value for the sample bird total body height (y axis) is (40.38 cm) with max value (46 cm) and min value (36 cm) and the mode value is (40 cm).
- The average value for the sample bird body length (z axis) is (34.42 cm) with max value (41 cm) and min value (31 cm) and the mode value is (35 cm).
- Finally the maximum bird space volume is (0.11 $m^3$) depending on the max values for each sample space axis.

Also the breast circumference considered as one of the important measurements for indicate the bird space shape. So, the average value for the sample is (43.46 cm) with max value (49 cm) and min value (36 cm) and the mode value is (44 cm).

- **The External Indices:**

As mentioned before the proportions of the different body parts are obtained by determining body configuration. The stockiness index which linked the breast circumference to the body length, the massiveness index which linked the live body weight to the body length and the long-leggedness index which linked the leg length and the body length were the three important indices which define the bird body ratio. And by using the equations mentioned in the methodology the most important exterior indices are calculated and shown on **Table (3).**

**Table (3) Birds External Indices**

| **The parameter** | **(Stockiness)** | **(Massiveness)** | **(Long-leggedness)** |
|---|---|---|---|
| | **%** | **%** | **%** |
| **Mean** | 126,26 | 5,83 | 22,87 |
| **Min** | 116,13 | 5,06 | 19,36 |
| **Max** | 119,51 | 6,36 | 26,83 |
| **Mode** | 125,71 | 5,69 | 22,86 |

Also table (3) shows that the massiveness index give ratio (1:5.8) between the body length in (cm) and the body weight in (kg) while the stockiness index give ratio (1:1.3) between the body length in (cm) and the breast circumference in (cm) and the long-leggedness index give ratio (1:0.23) between the body length in (cm) and the leg length in (cm).

- **Correlation coefficient value between the body measurements and the significant test:**

**Table (4)** shows the correlation coefficient value between each two body measurements beside the correlation significant.

**Table (4) Correlation coefficient value between the body measurements and the significant test**

| | w | **BL** | LL | BH | **SBH** | BW | **TBW** | BC | RSH | SH |
|---|---|---|---|---|---|---|---|---|---|---|
| W | 1 | *** | ns. | *** | *** | *** | *** | *** | *** | *** |
| **BL** | 0,56 | 1 | ns. | *** | *** | *** | *** | *** | ns. | ** |
| LL | 0,09 | 0,05 | 1 | * | *** | ** | ns. | *** | *** | ns. |
| BH | 0,46 | 0,38 | 0,15 | 1 | *** | *** | ns. | *** | *** | *** |
| **SBH** | 0,58 | 0,63 | 0,20 | 0,22 | 1 | *** | *** | *** | ** | ns. |
| BW | 0,59 | 0,44 | 0,18 | 0,56 | 0,45 | 1 | *** | *** | *** | *** |
| **TBW** | 0,45 | 0,48 | 0,07 | 0,08 | 0,51 | 0,31 | 1 | *** | ns. | ns. |
| BC | 0,50 | 0,30 | 0,23 | 0,36 | 0,31 | 0,40 | 0,40 | 1 | * | *** |
| RSH | 0,22 | 0,01 | -0,22 | 0,47 | -0,17 | 0,35 | 0,04 | 0,15 | 1 | *** |
| SH | 0,35 | 0,19 | -0,09 | 0,46 | 0,06 | 0,39 | 0,04 | 0,43 | 0,30 | 1 |
| | **Significant; * < 0,05, ** < 0,01, *** < 0,001** | | | | | | | | | |

The above table shows a correlation significant between body weight and all measurements with high significant degree except the leg length the correlation result was insignificant. Also the body length shows high correlation significant with all measurements except also the leg length and relax standing height the correlation result was insignificant. For stretching body height it also shows high correlation significant with all measurements except also relax standing height the correlation result was significant with medium degree but there is no significant correlation with the sitting height.

Also the above table shows the highly correlation significant between total body width and body weight, body length, stretching body height, body width and Breast circumference but with all other measurements it was insignificant correlation. Finally for the significant correlation of the Breast circumference the table shows highly correlation significant with all the measurements except relax standing height it shows low correlation significant.

- **Simple regression equations for bird body measurements:**

The next tables show the prediction equations for calculating the body measurement from the other measurements also the tables show the equation significant and its value beside the standard error finally the equations limits.

**Table (5) Body weight (W) prediction equations (gr.), significant and standard error.**

| Equation No. | prediction equation | standard error | Significant | |
|---|---|---|---|---|
| Eq. 13. | **W = 158.79 + 53.702 BL** | 4.611 | *** | 0 |
| Eq. 14. | **W = 1853.16 + 19.574 LL** | 13.169 | ns. | 0.138 |
| Eq. 15. | **W = 1205.12 + 43.854 BH** | 4.843 | *** | 0 |
| Eq. 16. | **W = - 327.84 + 57.827 TBH** | 4.663 | *** | 0 |
| Eq. 17. | **W = 1155.64 + 48.913 BW** | 3.835 | *** | 0 |
| Eq. 18. | **W = 256.33 + 34.25 TBW** | 3.912 | *** | 0 |
| Eq. 19. | **W = - 27.36 + 46.815 CC** | 4.647 | *** | 0 |
| Eq. 20. | **W = 1486.63 + 18.051 RSH** | 4.725 | *** | 0 |
| Eq. 21. | **W = 1146.15 + 58.536 SH** | 9.025 | *** | 0 |
| | **Significant; * < 0,05, ** < 0,01, *** < 0,001<br>(W) range between 1568 and 2608** | | | |

**Table (6) Body length (BL) prediction equations (cm), significant and standard error.**

| Equation no. | prediction equation | standard error | Significant | |
|---|---|---|---|---|
| Eq. 22. | **BL = 33.43 + 0.126 LL** | 0.137 | ns. | 0.362 |
| Eq. 23. | **BL = 27.66 + 0.37 BH** | 0.053 | *** | 0 |
| Eq. 24. | **BL = 8.26 + 0.648 TBH** | 0.047 | *** | 0 |
| Eq. 25. | **BL = 27.79 + 0.381 BW** | 0.044 | *** | 0 |
| Eq. 26. | **BL = 15.1 + 0.378 TBW** | 0.04 | *** | 0 |
| Eq. 27. | **BL = 21.92 + 0.288 CC** | 0.053 | *** | 0 |
| Eq. 28. | **BL = 34.11 + 0.011 RSH** | 0.05 | ns. | 0.830 |
| Eq. 29. | **BL = 29.71 + 0.320 SH** | 0.099 | ** | 0.001 |
| Eq. 30. | **BL = - 2.957 + 0.019 W** | 4.611 | *** | 0 |
| | **Significant; * < 0,05, ** < 0,01, *** < 0,001<br>(BL) range between 31 and 41<br>(BL) is the z axis** | | | |

**Continue table (6) Body length (BL) prediction equations (cm), significant and standard error.**

**Table (7) Leg length (LL) prediction equations (cm), significant and standard error.**

| Equation no. | prediction equation | standard error | Significant | |
|---|---|---|---|---|
| Eq. 31. | **LL = 6.75 + 0.061 BH** | 0.024 | * | 0.01 |
| Eq. 32. | **LL = 4.31 + 0.088 TBH** | 0.025 | *** | 0 |
| Eq. 33. | **LL = 6.77 + 0.063 BW** | 0.021 | ** | 0.002 |
| Eq. 34. | **LL = 6.62 + 0.025 TBW** | 0.019 | **ns.** | 0.202 |
| Eq. 35. | **LL = 3.81 + 0.093 CC** | 0.023 | *** | 0 |
| Eq. 36. | **LL = 10.24 - 0.082 RSH** | 0.021 | *** | 0 |
| Eq. 37. | **LL = 8.79 - 0.062 SH** | 0.042 | ns. | 0.139 |
| | **Significant; * < 0,05, ** < 0,01, *** < 0,001<br>(LL) range between 6 and 11** | | | |

**Table (8) Body height (BH) prediction equations (cm), significant and standard error.**

| Equation no. | prediction equation | standard error | Significant | |
|---|---|---|---|---|
| Eq. 38. | **BH = 8.87 + 0.233 TBH** | 0.059 | *** | 0 |
| Eq. 39. | **BH = 9.83 + 0.486 BW** | 0.042 | *** | 0 |
| Eq. 40. | **BH = 14.88 + 0.067 TBW** | 0.046 | **ns.** | 0.15 |
| Eq. 41. | **BH = 2.94 + 0.353 CC** | 0.053 | *** | 0 |
| Eq. 42. | **BH = 6.33 + 0.415 RSH** | 0.045 | *** | 0 |
| Eq. 43. | **BH = 6.42 + 0.807 SH** | 0.091 | *** | 0 |
| | **Significant; * < 0,05, ** < 0,01, *** < 0,001<br>(BH) range between 12 and 26** | | | |

**Table (9) Stretching body height (SBH) prediction equations (cm), significant and standard error.**

| Equation no. | prediction equation | standard error | Significant | |
|---|---|---|---|---|
| Eq. 44. | **SBH = 33.87 + 0.374 BW** | 0.043 | *** | 0 |
| Eq. 45. | **SBH = 20.42 + 0.391 TBW** | 0.038 | *** | 0 |
| Eq. 46. | **SBH = 27.89 + 0.287 CC** | 0.052 | *** | 0 |
| Eq. 47. | **SBH = 44.41 - 0.14 RSH** | 0.048 | ** | 0.004 |
| Eq. 48. | **SBH = 38.88 + 0.102 SH** | 0.097 | ns. | 0.293 |
| Eq. 49. | **SBH = 5.669 + 0.017 W** | 4.663 | *** | 0 |
| | **Significant; * < 0,05, ** < 0,01, *** < 0,001<br>(SBH) range between 36 and 46<br>(SBH) is the Y axis** | | | |

**Table (10) Body width (BW) prediction equations (cm), significant and standard error.**

| Equation no. | prediction equation | standard error | Significant | |
|---|---|---|---|---|
| Eq. 50. | **BW = 3.08 + 0.28 TBW** | 0.051 | *** | 0 |
| Eq. 51. | **BW = - 2.14 + 0.45 CC** | 0.06 | *** | 0 |
| Eq. 52. | **BW = 7.08 + 0.358 RSH** | 0.055 | *** | 0 |
| Eq. 53. | **BW = 5.77 + 0.791 SH** | 0.108 | *** | 0 |
| | **Significant; * < 0,05, ** < 0,01, *** < 0,001<br>(BW) range between 12 and 24** | | | |

**Table (11) Total body width (TBW) prediction equations (cm), significant and standard error.**

| Equation no. | prediction equation | standard error | Significant | |
|---|---|---|---|---|
| Eq. 54. | **TBW = 30.08 + 0.484 CC** | 0.065 | *** | 0 |
| Eq. 55. | **TBW = 49.92 + 0.042 RSH** | 0.064 | ns. | 0.514 |
| Eq. 56. | **TBW = 49.95 + 0.08 SH** | 0.127 | ns. | 0.532 |
| Eq. 57. | **TBW = - 7.484 + 0.029 W** | 3.912 | *** | 0 |
| | **Significant; * < 0,05, ** < 0,01, *** < 0,001<br>(TBW) range between 40 and 59<br>(TBW) is the X axis** | | | |

**Table (12) Breast circumference (BC) prediction equations (cm), significant and standard error.**

| Equation no. | prediction equation | standard error | Significant | |
|---|---|---|---|---|
| Eq. 58. | **BC = 39.68 + 0.131 RSH** | 0.052 | * | 0.012 |
| Eq. 59. | **BC = 32.16 + 0.769 SH** | 0.094 | *** | 0 |
| Eq. 60. | **BC = 0.58 + 0.021 W** | 4.647 | *** | 0 |
| | **Significant; * < 0,05, ** < 0,01, *** < 0,001<br>(BC) range between 36 and 49** | | | |

**Table (13) Relax standing height (RSH) prediction equations (cm), significant and standard error.**

| Equation no. | prediction equation | standard error | Significant | |
|---|---|---|---|---|
| Eq. 61. | **RSH = 20.07 + 0.596 SH** | 0.11 | *** | 0 |
| | **Significant; * < 0,05, ** < 0,01, *** < 0,001<br>(RSH) range between 21 and 33** | | | |

## CONCLUSION AND RECOMMENDATIONS

During sample consisted of 300 birds (Arbarecars – type1+) divided to 100 birds into 3 iterations, information on body weight and 9 body measurements was individually collected from all chickens sample and by using **(M Stat.)** package to analysis the data the targeted statistical parameters and measurements was indicated beside some other information. The follows are the important obtained results:

**The main bird space axis (X – Y – Z) and the maximum bird volume:**

- The average value for the sample bird total body width (x axis) is (51.12 cm) with max value (59 cm) and min value (40 cm) and the mode value is (50 cm).
- The average value for the sample bird total body height (y axis) is (40.38 cm) with max value (46 cm) and min value (36 cm) and the mode value is (40 cm).
- The average value for the sample bird body length (z axis) is (34.42 cm) with max value (41 cm) and min value (31 cm) and the mode value is (35 cm).
- The breast circumference considered as one of the important measurements for indicate the bird space shape. So, the average value for the sample is (43.46 cm) with max value (49 cm) and min value (36 cm) and the mode value is (44 cm).
- The maximum bird space volume is (0.11 $m^3$) depending on the max values for each sample space axis.

**The External Indices:**

- The massiveness index gives ratio (1:5.8) between the body length in (cm) and the body weight in (kg).
- The stockiness index gives ratio (1:1.3) between the body length in (cm) and the breast circumference in (cm).
- The long-leggedness index gives ratio (1:0.23) between the body length in (cm) and the leg length in (cm).

**Correlation coefficient value between the body measurements and the significant test:**

- The statistical analysis shows correlation with highly significant degree between most of the body measurements.

**Simple regression equations for bird body measurements:**

The following prediction equations can be used to calculate the important and targeted body measurements which have highly correlation and significant.

- **Total body width (TBW) prediction equation (cm) or the X axis from body weight:**

  **TBW = - 7.484 + 0.029 W ………Eq. 57.**

- **Stretching body height (SBH) prediction equation (cm) or the Y axis from body weight:**

**SBH = 5.669 + 0.017 W ……….Eq. 49.**

- **Body length (BL) prediction equation (cm) or the Z axis from body weight:**

**BL = - 2.957 + 0.019 W ……….Eq. 30.**

- **Breast circumference (BC) prediction equations (cm) from body weight:**

**BC = 0.58 + 0.021 W ……….Eq. 60.**

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**المراجع باللغة العربية**

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## الملخص العربى

# دراسات هندسية في مجال الانتاج المكثف للدواجن

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أصبحت الميكنة مدخل رئيسي في كل وسائل ومراحل ومجالات الانتاج الزراعي والتي تتضمن الانتاج المكثف للدواجن ، وكخطوة أساسية نحو تصميم أو تطوير أي وسيلة ميكانيكية يجب دراسة وتحليل المنتج الذي تتعامل معه تلك الوسيلة لذلك يجب دراسة المواصفات والخصائص الطبيعية الهندسية المهمة للدواجن والتي ترتبط وتؤثر في الوسيلة الميكانيكية المستخدمة التي تتعامل مع هذا المنتج الحي المتحرك. لذلك تم تصميم تجربة لدراسة بعض الخصائص الطبيعية الهندسية المهمة لطيور التسمين المكثفة تحت ظروفنا المحلية

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بداخل مزرعة تسمين الدواجن بكلية الزراعة / جامعة القاهرة وذلك لثلاث دورات انتاجية متتالية خلال الفترة من شهر سبتمبر حتى شهر ديسمبر ٢٠٠٩ و أيضا تم دراسة تأثير وارتباط هذه الخصائص على بعض المؤشرات الاخرى والتي تعتبر أساس هندسي عند تصميم او تطوير أي وسائل ميكانيكية تتعامل مع هذه الطيور. تكونت العينة العشوائية للتجربة من عدد ٣٠٠ طائر من نوع (Arbarecars – type1+) مقسمة الى ١٠٠ طائر في ثلاث تكرارات وباستخدام ميزان حساس وشريط قياس من التيل تم تسجيل وزن الجسم و ٩ قياسات جسمية لكل طائر من عينة الدراسة وباستخدام البرنامج الاحصائي (M Stat.) تم تحليل البيانات وتحديد المقايس والمؤشرات الاحصائية المستهدفة وكذلك بعض المعلومات الاخرى. أيضا تم حساب نسب ثلاث مؤشرات جسمية خارجية وهي مؤشر الضخامة (massiveness) ومؤشر الدمك (stockiness) ومؤشر طول الارجل (long-leggedness) وأخيرا تم تحديد اكبر قيم للثلاث محاور الرئيسية الفراغية ( X – Y – Z ) للطيور محل الدراسة وأيضا حساب اقصى حجم او حيز فراغي يشغله الطائر. والتالي أهم النتائج المتحصل عليها:

- أقصى حيز فراغي يشغله الطائر هو ٠.١١ م$^{٣}$ اعتمادا على اكبر قيمة لكل بعد فرغي للعينة محل الدراسة.
- أعطى مؤشر الضخامة نسبة ( ١ : ٥.٨ ) في حين أعطى مؤشر الدمك نسبة ( ١ : ١.٣ ) و أعطى مؤشر طول الارجل نسبة ( ١ : ٠.٢٣ ).
- أوضح التحليل الاحصائي وجود ارتباط بدرجة عالية من المعنوية بين معظم القياسات الجسمية.

و التالي المعادلات التنبئية التي يمكن استخدامها لحساب أهم القياسات الجسمية المستهدفة والتي لها أعلى درجات للمعنوية والارتباط:

- **العرض الكلي للجسم = - ٧.٤٨٤ + ٠.٠٢٩ وزن الجسم**
- **ارتفاع الطائر مشدود = + ٥.٦٦٩ + ٠.٠١٧ وزن الجسم**
- **طول الجسم = - ٢.٩٥٧ + ٠.٠١٩ وزن الجسم**
- **محيط الصدر = + ٠.٥٨ + ٠.٠٢١ وزن الجسم**