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EARLY WEANING OF PIGEON SQUABS

A. F. Abdel-Azeem, A. A. Amer, T.A.Shama and W. A. Abbas
Fac. of Agric., Al-Azhar Univ., Naser City, Cairo, Egypt

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ABSTRACT: The main objective of this study was to increase the reproductive performance and profitability of pigeons by weaning of squabs at 3rd d post-hatching. If parents did not need to feed their squabs for about 28 d more eggs would be obtained from each pair of pigeons, where new laying cycle is initiated after weaning. In the first 3 d of life it is very difficult to weaning squabs because they completely dependent on pigeon crop milk (PCM), which contains immunoglobulin and other unknown compounds necessary for survival. However, at the end of 3rd d of nestling period crop milk replacer (CMR) can be made and successfully given for squabs till the end of growth period. A total number of 135 squabs (36.01±1.7g) were taken at the end of 3rd d post-hatching, which was randomly divided into 3 groups (45 squabs / group) with 3 replicates containing 15 squabs for each. The previous weaning groups compared with the PCM which contains 45 squabs leaved with their parents as a control group. The weaning groups were artificially fed by 3 different CMR containing 42.14, 44.15 and 48.12 % CP and 3277.5, 3308.7 and 3371.1 ME kcal/kg. Squabs were hand fed with CMR slurries composed of soya flour based diet, with added gluten, eggs, powder milk, yeast, and supplemental minerals, vitamins and oil. Eggs and powder milk were added to duplicate the nutrient composition of CMR. In the first stage of weaning (3 - 14 d), CMR were given for squabs containing 14% diet and 86% water by weight, followed by 20 % diet and 80 % water for the next growth period (15-28 d). Results indicated that early weaning is a new method to increase frequency of reproduction of parent stock, where annual squab production increased. Growth rate of weaning squabs was not negatively ($P \leq 0.05$) affected by hand feeding compared to PCM group. However, growth rate for either PCM or CMR groups was quick until d 14 and then progressively decreased afterwards, where the negative growth rate occurs at the 5th wk. There were significant ($P \leq 0.05$) differences observed for most blood parameters due to feeding CMR. While, insignificant differences observed for most carcass traits, with exception of body weight, spleen, wing and abdominal fat weight percentages. However, CP % and EE % in whole carcass insignificantly affected due to feeding CMR. In general, it could be concluded that squabs have been successfully hand-reared by using CMR, where the major benefit seen with the applying early weaning is providing an economical benefit by allowing more squabs at the end of the year and increase overall fecundity.

Key Words: Early Weaning, Crop Milk Replacer, Squab Growth Rate.

Corresponding author: abdelazeem.fahmy@yahoo.com

INTRODUCTION

It's well known that pigeons (*Columba livia domestica*) have been reared for obtaining squabs all over the world. Mankind has practiced with pigeon keeping about 10,000 years in almost every part of the world (**Levi, 1977**). Probably pigeons are the first bird species to have been reared by humans (**Johnston and Janiga, 1995**). In developing countries like Egypt, pigeons are reared under semi scavenging system and mainly for squab production, where the Egyptians raised pigeons for food (**Levi, 1972**). In this context, **Fekete *et al.* (1999)** stated that the purpose of pigeons breeding was basically three categories: the production of sports pigeons, ornamental pigeons, and utility (meat type) pigeons. Additionally, squab meat is very lean, easily digestible, and richer in protein, minerals and vitamins (**Morgan, 2006**). Also, Chinese people consider pigeon meat as having medicinal value (**Hsiung *et al.*, 2005**). Pigeons are monogamous and squabs are raised by their parents, unlike chickens and other poultry. Newly hatched squabs an altricial birds, i.e. blind, and helpless when hatched and it's totally dependent on their parents with pigeon crop milk. However, pigeon crop milk and mammalian milk have functional similarities in terms of nutritional benefit and delivery of immunoglobulins to the young. When the squabs grow older pigeon crop milk is mixed with grains soaked in the crop of the parents and gradually replaced by the grains **(Sales and Janssens, 2003)**. Because of this special characteristic, the feeding system of pigeons differs markedly from that of other poultry species. The pattern of intestinal development during postnatal growth in domestic pigeons as an altricial bird would be different from the pattern observed in precocial poultry (**Dong *et al.*, 2012)**. They added that villus area in squabs increased rapidly in all segments immediately after hatching and was greatest in the duodenum. In the ileum, this increase was complete by 5 d, whereas in the duodenum and jejunum, villus size continued to increase through 14 d. However, altricial birds exhibit a rapid growth after hatching that is accompanied by maturation of their physiological functions (**Starck and Ricklefs, 1998**). Furthermore, the digestive tract plays a key role in studies of avian ontogenies because of its important function in nutrient intake (**Starck, 1993**). Young pigeons are altricial birds and exhibit a phenomenal rate of growth and a rapid growth of the small intestine in the first few weeks after hatching (**Shetty *et al.*, 1992**). Moreover, **Vandeputte-Poma (1980)** found that until 3 d all young pigeons receive pigeon crop milk only. The relative crop contents of squabs is maximal until 4 d after hatching and shows a first steep decline at 8 d coinciding with a decrease in the relative quantity of pigeon crop milk. As a result, precocial birds have the capacity to digest and use complex dietary nutrients at hatch, whereas squabs need a much more simple diet and cannot seek food on their own to satisfy their nutrient requirements. A pair of pigeons can raise about 15 squabs per year. Although meat from squabs is produced commercially, information regarding breeding techniques and advances is lacking (**Mariam, 2007**). Indeed a few attempts have been made to hand-feeding squabs but not always from the day of hatching (**Levi, 1974; Du *et al.*, 1993** and **Tsat *et al.*, 1994)**. Furthermore, crop milk replacer could be used for hand feeding, so that parents would continue to laying a new clutch approximately after short period of removing squabs by decreasing the dependence of pigeon crop milk. Considering the above facts and circumstances the present study was conducted to investigate the possibility of

hand feeding of squabs in early life (3rd d post-hatching) in order to maximizing the profitability, where pigeon is a species with a moderate economic importance.

MATERIAL AND METHODS

Site and the aim of study: This study was conducted at Experimental Poultry Research Station belonging to Al-Azhar University, Naser city Cairo, Egypt during the period from June, 2014 up to December, 2014. The main objective of this study was to investigate the possibility of early weaning and hand feeding of squabs at 3rd d post-hatching in order to maximizing the profitability and increase reproduction performance of parents stock.

Parents stock and management: The experiment was conducted using 60 pairs of local parent Egyptian pigeons with a (sex ratio of 1:1). The birds were housed in an environmentally controlled, windowless pigeon house pens. The pens were prepared with batteries, which were hanging on the inner wall of the pens. Each battery was divided into holes as nests measuring (30 x 25 x 30 cm). Each nest was numbered to follow up the growth rate of squabs leaved with their parent's. Pigeons were fed a basal diet based on corn-soybean meal diet containing 14% CP and 3200 Kcal/Kg, supplemented with minerals and vitamins according requirements published by **Abdel-Azeem *et al.* (2007)**. The lighting schedule was 16 hrs light and 8 hrs darkness, with a light intensity of 2.5 w/ m^2. At the end of brooding period 135 squabs were taken at 3rd d post hatching (weaning age) to hand feeding procedure. The weaning group compared to squabs leaved with their parents as control group (45/group). Parents started to lay a new clutch again after approximately 7-10 d from removing of squabs.

Rearing and hand feeding method of squabs: From 1 to 3 d of hatching, squabs received pigeon crop milk only, where they full dependent on their parents. While, at the end of 3rd d post hatching a total number of 135 squabs (36.01±1.7g) were taken and randomly divided into 3 groups (45 squabs / group) with 3 replicates containing 15 squabs for each. The previous weaning groups compared with the PCM contain 45 squabs, which leaved with their parents as a control group. The weaning groups were artificially fed by 3 different CMR containing 42.14, 44.15 and 48.12 % CP and 3277.5, 3308.7 and 3371.1 ME kcal/kg. After taken squabs from their parents they were brooded in a special glass brooder, where the temperature was maintained at 35 ºC for the 1st wk, 32 ºC for the 2nd wk, and then gradually decreased to 28-25 ºC for the 3rd and 4th wk respectively. Brooder was provided with ultra violet lamp to sterilize surrounding environment. Adjusting temperature is very important in early life because squabs can only properly digest their food if their normal range of body temperature is ensured. However, the relative humidity was stable (60-65%) along the growth period. Each two squabs placed in a disposable nest bowl measured 10 cm deep, and 25 wide provided with straw as nesting material. A numbered leg band was given for each squab at 7th d of age for identification and easier visual observation. The formulation and chemical compositions of crop milk replacer compared with pigeon crop milk were given in Tables 1 and 2. In the first stage of weaning (3 - 14 d) CMR were given containing 14% diet and 86% water by weight, followed by 20% diet and 80% water for the next period of life (15 - 28 d). Squabs were fed as soon as possible after they taken from their parents at 3rd d post-hatching. Before commencement of hand feeding squabs were stimulated by touching their bills and crops for 1 min before feeding. Slurry of diet blended in distilled water in a homogenizer, and then warmed to 37 ºC. During the first stage (3-14 d) squabs were fed the slurries 2

times / d at about the same times, so that their crops were full by using a 50 mL plastic syringe attached to a soft and flexible rubber tube. In the next stages (15-28 d) squabs were fed 3 times / d by using the same plastic syringe. The actual amount of slurry fed to each squab was daily recorded. The CMR should be heated before using by standing it in a bowl in boiling water. It is important to test the temperature of the formula on the back of the hand before feeding. If mixture is too hot it will, of course, burn the squab and, if it is too cold, it harmful to squabs. If the diets are too dilute, the birds do not receive enough dry matter for optimal growth. This confirms the importance of dilution of diet for the survival of hand-fed squabs as observed in cockatiels (**Roudybush and Grau, 1986)**. Squabs are fed initially by slightly pressing open the mouth and to push the formula into the mouth. The formula needs to be fairly runny at this stage to enable it to flow into the mouth. It is important to fill the crop to its maximum capacity in order to stretch the walls of the crop in preparation for the large volumes of food which will be eaten later. To prevent impaction, it is very important that the crop be allowed to fully empty before it is filled again. However, formula can be feed again after the crop has emptied fully and feeding has paused for 12 hrs to minimize the risk of bacterial residues in the crop which might restart the fermentation. Also, as the squabs continue to grow larger the thickness of the formula can be increased and the delivery method will need to be changed. A good indicator that the rearing process is going well is that the squab crop is emptying between feeds. For hand feeding procedure, we hold the head of squab between the thumb and forefinger and offer the tip of rubber run it down the mouth. Fill crop at each feed and do not allow it to empty during the day, but leave it to empty overnight. This is the most important part of the method and is crucial for successful hand-rearing. Squabs, who suffered from fermenting crop content once, are prone to recurring bouts of faulty digestion. Problems can be minimized by adding more enzymes to the formula to aid proper digestion. With this method, however, the crop should be filled at each feed and should remain full throughout the day and be allowed to empty only overnight. Most squabs pass faces after each feed and this is generally a good indicator that all is going well. If it appears that the squab is not digesting the formula and has stopped passing faces, increasing the humidity in the brooder may help to solve this problem. Visual observation is necessary along day to solve any problems can be arise.

Parameters

Body weight and feed intake: During the growth period body weight of each squab was daily recorded in the early morning before feeding after the squabs had been starved until excretion of faces and urine before the weight of the birds was recorded. Also daily and total feed intake per squab, and mortality rate were also recorded. All mortalities occurred during experiment had post-mortem examination to determine the reason of death.

Blood samples: Blood samples were taken at 28 d of age for each group alone. Each blood sample was divided into two samples in Eppendorf tubes. One in a heparinized test tube to study blood hematological parameters including packed cell volume (PCV), hemoglobin (Hb), red blood cells (RBC's), white blood cells (WBC's) and the other in a heparinized test tube to study blood biochemical constituents including total plasma protein profile, total plasma lipids profile, some liver enzyme and kidney function. Samples were sorted in a deep freezer at -20 ^{o}C until the time of chemical analyses were carried out. Blood samples were analyzed within 3 hrs of their collection for hematological parameters. Either, RBCs and WBCs count were done

in a haemocytometer chamber with (**Natt and Herrick, 1952)** diluents to obtain a 1:200 blood dilution. The number of WBCs was estimated as total WBCs x 200. However, PCV was measured as micro haematocrit method according to **Norte *et al.* (2008)**. The Hb concentration was also determined by spectrophotometerically method according to (**Young, 2001)**. The means of corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC) and color index (CI) were calculated from RBCs count, PCV and Hb values. The biochemical parameters of the blood were calorimetrically determined by using commercial kits (Spectrum Egypt Company and Diamond diagnostics for biotechnology kits), for total protein and albumin (**Tietz *et al.*, 1995**), total lipids (**Frings *et al.*, 1970**), ALT and AST (**Murray, 1984a,b**), glucose (**Kaplan, 1984**), total cholesterol and triglycerides (**Young, 1995**), LDL and HDL (**Lopes-Virella *et al.*, 1977**), urea (**Young, 1995**) and uric acid (**Barham and Trinder, 1972**). Globulin concentration was calculated as difference between total protein and albumin.

Carcass traits, carcass chemical and crop milk replacer compositions: At 28 d of age 15 squabs per each treatment (5/ replicate) were weighed, sacrificed and left to bleed for 3 minutes and then scalded at 60^{o}C for 1 minute, after that they were feathered and manually eviscerated to study carcass characteristics. Each carcass (including total edible and inedible parts) was weighed to record the dressing carcass weights. All values were calculated as percentages of live body weights. Abdominal fat pad were removed and weighed and the length of small intestine was measured. In order to determine carcass compositions, five carcasses were taken from each group after measuring carcass characteristics. Carcasses were frozen at -20^{o}C until analysis. For determining dry matter and moisture contents, carcasses were dried in an oven at 100^{o}C for 6 hrs. The whole dried carcasses were then homogenized after drying using a Waring 4L blender. Sample were taken and finely ground to analysis. Dry matter was determined as percentages of total wet carcass weight. Total carcasses and formula protein (Nx6.25), ash and ether extract (EE) were analyzed according to **A.O.A.C. (1994)**. Ether extract was determined by extraction using the Soxelt apparatus. The percentages of nutrients were reported on a DM basis. The amino acid profile in formula was performed by Eppendorf apparatus HPLC *(Amino acid analyzer LC 3000 Eppendorf Germany)* at flow rate of 0.2 ml/min. Pressure of buffer from 0 to 50 bars. Pressure of reagents ranged from 0 to 150 bars, where the reaction temperature was 123^{o} C.

Data analysis: Data analysis was performed using General Linear Models (GLM) procedure of **SPSS** software program package **(SPSS, 2010)**, version 16.0. All data were analyzed based on a completely randomized design using one way ANOVA. All percentages were first transformed to arcsine being analyzed to approximate normal distribution before ANOVA. Data were presented as means ± SE. Significant differences among treatment means were separated using Duncan's multiple range tests with a 5% probability (**Duncan, 1955**). Also the one-sample *t*-test is used for comparing differences between sexes. All obtained data were analyzed by using the following Model: $\mathbf{Y_{ij}= u +S_i+ e_{ij}}$

Where, $\mathbf{Y_{ij}}$ = is the analyzed measurements, **u** = is the overall mean, $\mathbf{S_i}$ = is the effects of groups (i=1-4) and e_{ij} = the standard error of mean.

RESULTS

Ingredients used in formulating crop milk replacer (CMR) and chemical compositions compared with pigeon crop milk (PCM): Table 1 and Table 2

shows the ingredients used in formulating CMR and chemical compositions compared with PCM. It appeared that CMR slurries composed of soybean full fat flour based diet, with added gluten, eggs, powder milk, sunflower oil, sodium chloride, calcium carbonate, di-calcium phosphate, yeast and supplemental with minerals and vitamins. These ingredients were suitable for successful and complete digestion in early life of squabs and supported the optimum growth for squabs. Eggs and powdered milk were added to duplicate the nutrient compositions of CMR. Also, yeast was added to promoting blood formation, where it considered a source of vitamin B-complex. It is interesting to note that from Table 2, PCM contains relatively higher amount of CP, EE, ash, GE and different amino acid including lysine, aspartic, therionine, serine, glutamic, proline, glycine, valine, isolucine, leucine, phenylalanine, histidine and arginine than finding in CMR. While, CMR containing suitable content of CP and EE % and also has relatively higher levels of methionine, cystine, serine, alanine and tyrosine than PCM. It is obvious that CMR was successfully formulated to meet the nutrient requirements required for normal growth of squabs during the nestling period.

Hand feeding and performance: Results presented in Table 3 show the effect of CMR on squab performance compared to squabs fed PCM (control group). It is appeared that live body weight (LBW) at 3 d post hatching were found to be 34.45, 35.58, 36.32 and 37.67 g respectively for PCM,CMR1,CMR2 and CMR3, indicating the absence of significant differences at start. Statistical analysis of comparative abundance of LBW among control and CMR groups revealed that insignificant differences detected for all growth periods for squabs fed either PCM or those fed CMR groups. Concerning, body weight gain (BWG) the obtained results exhibited the same trend, with exception of BWG at 3-7 d, where squabs fed PCM exhibited higher ($P \leq 0.05$) value than squabs fed CMR. While, for other growth periods insignificant differences observed due to feeding neither PCM nor CMR. It is very interesting to note that, although, the absence of significant among the groups, there were numerical increase of LBW due to feeding CMR. Clearly from these results it is notice that growth of squabs was quick during the first 28^{th} d, it reached the peak, while it decreased or stopped afterwards. However, it's realized that the highest BWG observed during the first period of growth (8 - 14 d) compared to other periods. Interestingly, it should be obvious that LBW of squabs not affected by application of hand feeding procedure. This indicates that CMR can be used as a successful method in early life of squabs without any negative effect on growth rate. It is note that insignificant differences showed for mortality rate due to feeding CMR. This reflects no detection of fermentation or infectious diseases due to feeding CMR and all mortality occurred along the experimental study attributed to handling procedure. The results indicated that squabs fed CMR consumed equal amount during the nestling period and the values of CMR consumed recorded higher ($P \leq 0.05$) amount than observed for PCM group. The values recorded for total feed consumed were 925, 1007, 1007 and 1007 mL respectively for PCM, CMR1, CMR2 and CMR3. While, the values of FCR significantly affected among the experimental groups. The values of protein intake recorded high value for squabs fed by their parents compared to those supplemented CMR. Converse trend observed for energy intake, where squabs fed CMR showed higher values than squabs fed CMR. Concerning protein and energy efficiency ratio squabs fed CMR exhibited higher ($P \leq 0.05$) values than squabs fed by their parents (PCM). From the finding it is observed that early hand

feeding of squabs obviously no affects on all growth performance.

Growth rate for both sexes: Results illustrated in Table 4 and Fig 1 shows the averages of growth rate for male and female at different periods of growth regardless of feeding CMR. The average LBW at 3 d post hatching was 40.08 g vs. 31.92g for male and female. Afterwards, squab's weight continued to increase with advanced age till the end of nestling period. The average LBW at marketing age was 391.64 for male *vs.* 302.16 for female. It is notice that growth rate was quick for both sexes until 28, where it gradually decreased and negative growth rate occurred in week 5. In this context, for all periods of growth male were superior in its growth rate than female.

Blood constituents: The values of hematological and biochemical constituents of squabs fed either PCM or CMR are presented in Table 5. Concerning hematological parameters it will be noted that squabs fed CMR3 exhibited significantly ($P \leq 0.05$) higher values for RBCs count than other groups. While, insignificant differences observed for WBCs, heterophils, lymphocytes, heterophils / lymphocytes (H/L) ratio, due to feeding either CMR or PCM. On the other hand, the values of PCV and Hb recorded markedly significant ($P \leq 0.05$) higher values for squabs feed CMR3 than squabs fed other CMR or PCM. While, insignificant differences observed for erythrocytes indices including MCV, MCH, MCHC and CI among the experimental groups. It is interesting to note that RBCs positively affected due to feeding CMR, while no changes observed in WBCs and H/L ratio indicted no stress was observed, where the ratio of H/L is positively related to the magnitude of the stress event. Regarding results of biochemical constituents, it seems clear from these data that most of biochemical constituents significantly ($P \leq 0.05$) affected by the application of CMR compared to PCM. It is noted that the pronounced highest values of total protein and globulin recorded for squabs fed CMR compared to squabs fed PCM. While insignificant differences observed for albumin among the experimental groups. However, A/G ratio exhibited significantly high value for squabs fed PCM, followed in descending order by squabs fed CMR3, CMR2 and CMR1 respectively. In this context, it is seems likely that lipids profile fractions recorded significant ($P \leq 0.05$) higher values for squabs fed CMR3 than other groups. Concerning values of glucose, ALT, AST, urea and uric acid, the analysis of variance indicated that also squabs fed CMR3 showed the highest ($P \leq 0.05$) values compared to squabs fed other CMR or PCM. The values of AST/SLT ratio recorded the highest value for squabs fed CMR2 compared to other experimental groups. From the previous results it is pointed out that, although the increase values of all biochemical blood traits due to feeding CMR, all values are within the normal rang detected for most poultry species.

Carcass traits: Results of carcass traits measured at 28 d of age are given in Table 6. It is observed that all carcass traits insignificantly affected due to feeding CMR, with exception, of LBW, spleen, wings and abdominal fat weight percentages compared to squabs fed by their parents (PCM). The average LBW was found to be 330.34, 342.82, 345.36 and 351.43g respectively for PCM, CMR1, CMR2 and CMR3, where the statistical evaluation indicated that LBW was significantly ($P \leq 0.05$) higher for squabs fed CMR than those fed PCM. However, abdominal fat weight percentage progressively ($P \leq 0.05$) increased due to feeding CMR3, followed squabs fed CMR2, CMR1 and PCM. It is observed from the present results feeding squabs on CMR no adverse effects on carcass traits.

Chemical carcass compositions: Table 7 shows the details of the proximate analysis

of meat squabs at d 28 as affected by feeding CMR compared to meat of squabs fed by their parents (PCM). Carcass compositions were expressed as percentages of dry matter basis. It's apparent from inspection of table that moisture content in breast and whole carcass recorded slightly lower ($P \leq 0.05$) values for squabs fed CMR than squabs fed PCM, while, moisture content in thigh insignificantly affected due to feeding CMR or PCM. On contrary, the dry matter contents, exhibited higher ($P \leq 0.05$) values for carcass squabs fed CMR than squabs fed PCM. While, there were insignificant differences detected in crude protein and ether extract contents due to feeding CMR. Concerning ash percentages the highest values recorded for different cuts of squabs fed by their parents (PCM) and squabs fed CMR1 compared to those recorded for squabs fed CMR2 and CMR3.The values of NFE exhibited the lowest values for squabs fed CMR3 compared to other experimental groups. It's clear that from the previous results the feeding squabs on artificial CMR no negatively effect on carcass compositions, especially regarding with CP and EE%.

DISCUSSIONS

Ingredients used in formulating CMR and chemical compositions compared with PCM: From Table 1 and 2 it should be emphasized that CMR formulation in the present study mimics the composition of PCM, where the nutrients found in CMR similar nutrients observed in PCM during the nestling period. Extruded full-fat soybean flour can be used in formulating CMR; this may be due to it considered a good source of energy and protein with a high content of lysine, tryptophan, isoleucine, valine, and threonine (**Larbier and Leclercq, 1994**). Also, it contains 180–220 g/kg of good quality oil mainly with a high proportion of linoleic acid (**Waldroup, 1982**). However, the addition of yeast in CMR increased the number and height of intestinal villis and improved intestine maturation and villis formation which increasing the surface of nutrient absorption **(Banerjee and Pradham, 2006)**. Yeast could improve feed conversion ratio, and lowering the pH in intestinal segments, which creates a hostile environment for pathogens that reducing their chance of survival and colonization in the gut **(Tangendjaja and Yoon, 2002)**. Further, yeast are bio-stimulators and immune-modulators containing live bacterial cultures, which regulate and optimize the ratios among the different types of microorganisms in the digestive system, preventing upsets and exerting a stimulating effect on the disintegration and absorption of the nutrient substances **(Balevi *et al.*, 2000)**. However, eggs were added to formula due to the fact that it contains a great variety of nutrients to sustain both life and growth (**Kerver *et al.*, 2002**). Egg proteins have unique biological activities with a good balance of essential amino acids. In addition to excellent nutritional value immunoglobulin (IgY) is the major antibody present in yolk, which effective in preventing many bacteria and viruses infections (**Shin *et al.*, 2002**). The content of vitamins and minerals are needed in CMR in varying amounts, to allow squab healthy grow and develop. The deficiencies of vitamin and mineral can lead to fatigue, illness and disease, because they play important roles in bodily functions such as metabolism, immunity and digestion. Because high nutrient concentration of PCM makes it difficult to devise an artificial substitute for hand-rearing squab especially from the moment of hatching to 3 d post hatching. However, after 3 d post hatching soy based formula can be used as a substitution. On the basis of analyzing the compositions of CMR compared to PCM, it is observed that the contents of CP, EE, ash and most of amino acid appeared to be much lower in CMR than PCM during the different periods of

nestling. But CMR contains high amount of methionine, cystine, serine, alanine and tyrosine. **Hedge (1973)** found that pigeon milk contains 74-75% water, 14.19% protein, 7.75 % fat, 1.03% ash. Also he added that the amino acids values as a percentage of protein were glutamic acid 14.19, aspartic acid 11.34, leucine 8.96, lysine 5.87, valine 5.61, phenylalanine 5.50, therionine 5.49, arginine 5.48, tyrosine 5.36, alanine 5.30, serine 5.20, glycine 4.99, isoleucine 4.50, proline 3.19, methionine 2.48, tryptophan 2.80, histidine 1.52, and cystein 0.34. In this study we have shown that PCM is practically devoid of carbohydrates and information is lacking about the tolerance of squabs for carbohydrate-rich substitute diets during the first 3 d of age. It's observed, CMR contains carbohydrate (3.65 to 3.96%), while PCM devoid of carbohydrate. The characteristic lack of significant carbohydrate levels in PCM reflected that it is a holocrine secretion, consisting primarily of epithelial cells (protein) and lipid droplets (**Kirk Baer, 1999**). The composition of PCM changed and nutrients reduced with the increase of squab age. This result is consistent with **Abdel-Azeem (2010)** indicated that chemical composition of pigeon milk was changed through the nestling period. According to **Kirk Baer and Thomas (1996)** indicated that dry matter, fat, protein, and other nutrients in pigeon milk do not change between 1-3 d post-hatching. However, pigeon milk is highly nutritious, consisting of protein (60%), fat (32–36%), carbohydrate (1–3%). Also, **Sim *et al.* (1986)** found that crop milk contained 64-82% water, 11-18.8% protein, 4.5-12.7% ether extract, 0.8-1.8% ash and carbohydrate 0.0-6.14%. When squabs grow older, pigeon milk is mixed with grains soaked in the crop of the parents and gradually replaced by grains (**Vandeputte-Poma, 1980**). Interestingly, there is a unique factor present in pigeon milk that is required for squab growth and development. Until 3 d post hatching all squabs receives pigeon milk only, where after 3 d pigeon milk formation already declines in both sexes regresses after 13 d of feeding (**DE-Cock, *et al.*, 1991)**.

Hand feeding and performance of squabs: It's appeared that from Table 3 squab older than 3 d have been successfully hand-reared by feeding CMR formula. As with all bird hand-rearing protocols, it is essential to monitor fecal consistency and squab appetite, as well as daily weight gains to evaluate response to CMR diets. On many occasions in the past hand-rearing was attempted but there were high rates of failure. Several methods have been successfully used to hand-rear *Columbidae* (**Harrington *et al.*, 1999**). But a few attempts have been made to hand feed squabs, but not always from the day of hatching (**Levi, 1974; Du *et al.*, 1993 and Tsat *et al.*, 1994**). Unlike other avian specie, pigeons are monogamous; squabs hatch with unopened eyes and cannot digest adult birds' diets (**Kirk Baer, 1999**), where they receive PCM only until 3 d. The relative crop contents of squabs is maximal until 4 d after hatching and shows a first steep decline at 8 d coinciding with a decrease in the relative quantity of pigeon milk (**Vandeputte-Poma, 1980**). With hand feeding the diet must be diluted with water before diets move down the crop into the intestinal tract. In the first stage of weaning (3 - 14 d) 86% water is recommended and 80% for 15-28 d, and nutrients in diets suitable for hand rearing (**Yang and Vohra, 1987**). The performance of squabs feed CMR compared to squabs fed by their parents revealed statistically insignificant differences concerning LBW and BWG due to feeding slurries diets. Although the absence of significant squabs fed CMR exhibited numerical increase of LBW compared to squabs fed PCM. However, the highest LBW observed for squabs fed CMR3 compared with other CMR. It is notice that the highest LBW occurred

during 28 d, where afterwards (35 d) growth rate stopped or decline. This may be due to squabs during 28 d received either PCM or CMR , which containing higher levels of crude protein, total lipid, amino acids and gross energy, enhanced the growth rate of squabs. However, subjecting squabs to hand feeding no negative effect LBW and BWG during the different periods of growth compared to squabs fed by their parents. This finding attributed to CMR resembles PCM, where CMR contains suitable nutrients meets the requirements of hand-fed squabs for optimal growth during the growth period. However, the present study indicated although PCM was superior in its contents of nutrients than artificial formula, CMR can be successfully used in hand feeding of squabs to reach marketable LBW (346.9 g) without any adverse affect on performance or health status. The results of **Abdel-Azeem (2010)** indicated that pigeon milk containing higher percentages of protein, lipids amino acids and gross energy, which were very important in feeding and growth of squabs. Also, **AbdelAzeem (2005)** showed that growth rate of squabs were very higher during the 28th d of age and the increase in weight afterwards was very poor. The finding of **Bolla (2007)** stated that squab was slaughtered at about 28 and 30 d with an average 397.73 g. However, the amount of feed given for squabs at different periods is constant and dependent on squab weight. Total feed consumed during the whole period also differ among the experimental groups. Diet formulation had no significant effect on feed intake given for squabs. According to **Bokhari (2002)** reported that a pair of squab will consume about 45.30-56.6 g feed/day. Also, **Assaduzzaman (2008)** stated that the quantity of feed supplied for pigeons range from 32-37 g/d, with an average of 34.5 g/d. **Miguel *et al.* (2002)** found that squabs up to 12 d were fed five times per day, while older squabs were fed only three times per day and squabs older than 21 d were weaned progressively. **Darwati *et al.* (2010)** showed that the pigeon fulfilling requirement of maintenance only during brooding (55-58g/d/pair), a pair of pigeon needed feed 83-99 g/d for suckled two squabs. The pigeon milk is a holocrine secretion is fed to squabs exclusively for approximately the first 3 days of life and then a gradually increasing portion of adult diet is mixed into the food as the chick matures. They added that feed conversion of squab was high, this was because of high growth rate occurs during the first three weeks. It then decreased at the fourth and fifth weeks due to reductions in growth rate of squab. This indicates that feed efficiency decreased with the increased in age. This result is in agreement with **Levi (1954)** who reported that for six or seven d, body of squabs seems to double in size. After 26 to 28 d of hatching, the squab has reached the peak of its growth. Moreover, **Bokhari (1994)** indicated that squabs grow very rapidly until about 21 d, and then the growth continued at slower rate thereafter. Feed conversion of squab was best because of high growth rate occurs during the first three weeks of age. It then decreased at the fourth and fifth weeks due to reductions in growth rate of squab. This indicated that feed efficiency decreased with the increased squab age. **Antawijaya (1988)** reported that feed conversion of Homer King squab was 3.68. Improved weights can be obtained by hand feeding squabs when they are reaching to 10 d old.

Growth rate of squabs: It is evident from Table 4 and Fig 1, on the contrary to the most of the poultry species, high growth rate of squabs occurs during the first three weeks, where growth rate was quick until d 14, and it gradually decreased and negative growth rate occurred in week 5 due to decreases of feed efficiency with the increased age **(Darwati *et al.*, 2010)**. However, **Abdel-Azeem (2005)** showed that growth rate of squabs were very higher during the 28th d of age and the

increase in weight afterwards was very poor. Also, **Abulude *et al.* (2006)** showed that the male pigeon is heavier than the female. However, the current study clearly demonstrated that male show higher growth rate for all growth periods, than observed for female, this is due to the fact that males had better feed conversion than females, indicating their greater feed efficiency. The growth performance and developing of pigeon squabs are of crucial importance for meat production (**Janssens *et al.*, 2000**). These results are agreed with **Jane (2005) and Bolla (2007)** observed that live weight of the male pigeon is larger and heavier than female. **Vandeputte-Poma (1980)** reported that squabs fed pigeon milk increased their body weight by 22 fold in the first 3 weeks after hatching. Contrarily **Levi (1974)** who indicated that growth rate of squabs is very rapid, especially at the first 7^{th} d of age and the growth peak was during the 26^{th} - 28^{th} d of age.

Hematological and biochemical blood parameters: From data illustrated in Table 5 it's clearly indicate that the knowledge of hematological parameters is still remains incomplete and there are only few reports on the parameters of blood count in pigeons. It is interesting to note that artificial CMR had no negatively effect on all hematological parameters, where all measurements were within the normal range values observed for pigeons or different poultry species. This indicates that CMR has beneficial effect on hematological status nearly similar to squabs fed PCM. However, blood act as a pathological reflector of the status of the exposed animals to toxicants and other conditions, where blood constituents change in relation to the physiological status of an animal (**NseAbasi *et al.*, 2014**). There are great differences in RBCs due to feeding squabs on CMR. Results indicated although the increase of RBCs in squabs fed CMR3 compared to other groups, it were within the normal range of established values of racing pigeon (**Fourie and Hattingh, 1980**), and homing pigeon (**Bordel and Haase, 1993**). On contrast, WBCs count, hetrophils, lympohcytes, and H/L ratio were not negatively affected reflecting no stress due to feeding CMR. The results indicated WBCs values are within the normal range for healthy domestic chickens (**Riddell, 2011**). The WBCs play prominent role in disease resistance, especially with respect to the generation of antibodies and the process of phagocytosis. This could explain the reason of high degree resistance to disease reported for squabs where all mortalities recorded during the experimental period may be attributed to handling procedure. The WBCs counts observed in our study are similar to the data reported previously for racing pigeons (**Scope *et al.*, 2002**), feral free living pigeons (**Pavlak *et al.*, 2005**) and African collared doves (**Lashev *et al.*, 2009**). This finding is in agreement with **Kececi and Col (2011)** found that average numbers of WBCs were within the normal values of the majority of bird species. In respect to H/L ratio, this considered important information for immune system and were within the normal range in pigeons (**Vleck *et al.*, 2000**). The data revealed that higher PCV and Hb values were observed in squabs fed CMR. This attribute to increase RBCs count, because there was good correlation between the PCV and RBC counts and between the haematocrit and hemoglobin values **(Lloyd and Gibson, 2006)**. It is observed PCV and Hb values are important haematological parameters, which are of importance in the assessment of health status and disease of birds (**Hawkey *et al.*, 1984**), and are good indices of livestock adaptability to prevailing environmental conditions (**Kaushish *et al.*, 1976**). However, the values of PCV were within the ranges of those reported of racing pigeon (**Fourie and Hattingh, 1980**) and homing pigeon (**Bordel and Haase, 1993**). However, the

present study shows RBCs indices including MCV, MCH, MCHC and CI insignificantly affected due to feeding CMR. This may be due to RBCs are large and positively affected by application of hand feeding procedure. The results of **Seiser *et al.* (2000)** indicated that the hematological parameters are different in various species, including domestic and wild pigeons, MCH and MCHC values, were 39-42 pg and 22-25 g/dl. Generally, **Merck Manual (2012)** showed that haematology refers to the study of the numbers and morphology of the cellular elements of the blood, the red cells (erythrocytes), white cells (leucocytes), and the platelets (thrombocytes) and the use of these results in the diagnosis and monitoring of diseases. In the present study, there were significant differences detected in protein profile, with exception of albumin value. It is well known that plasma protein play a crucial role in maintaining homeostasis, but vales recorded remained within physiological limits throughout the experiment. However, the concentration of albumin was considered as a reflection of the animal ability to synthesize and store protein. The increase of protein profile for squabs fed CMR; this is attributed to high protein digestibility since high protein serum is an indicator of protein adequacy (**Ahamefule *et al.*, 2006**). Also, the increase portion profile may reflect an increase in the hepatic function **(Ashour *et al.*, 2004)**. The values of blood protein determined correspond to the values stipulated by (**Lumeij and Maclean, 1996)** in healthy pigeons. The decrease on A/G ratio seems to be due to the increase in globulin rather than albumin. This may reflect the positive increase in the immunity through increasing the gama-globulin (**Moore *et al.*, 1988)**. Furthermore, the present result showed that the lowest A/G ratio, was the best ratio as a good indicator for increasing the immunoglobulin, subsequently, the immunity responsiveness **(Ismail *et al.*, 2002)**. Concerning lipid profile, squabs fed CMR have higher values than squabs fed PCM. Concentration of lipid profile in the blood is strongly influenced by the quantity and quality of fat in the diet. Variations in lipid profile levels were a mirror image of daily intake of diet. It is evident that varied results of lipid profile are attributed to the differences in ME levels of the diets and the narrow between calorie and protein ratio **(Chen *et al.*, 2011)**. Also, it is notice that wide variation of cholesterol and triglyceride levels depend more on the effect of diet (**Harr, 2002**). The higher lipid profile for squabs fed CMR3 could be attributed to the high content of fat as measured by the amount of abdominal fat pad, when birds were slaughtered. Although the increase of lipid profile due to feeding CMR, the varying levels were found to be within the normal range previously determined in various avian species and pigeons. The values detected in this study are within normal range detected in pigeon observed by **Abdel-Azeem *et al.* (2007)**. In our study, the highest glucose values showed for squabs fed CMR3 compared with squabs fed other CMR and PCM. It is well known that more than one third of glucose absorbed by birds during a meal is converted to lactate by the cells of the intestine before entering the circulation (**Riesenfeld *et al.*, 1982**). The increase blood glucose seen after CMR consumed may have been due to increased glucose release from splanchnic tissue. The values detected in the present results similar data published by **(Mohsenzadeh *et al.*, 2015)** in pigeons. However, there were significant increase were found in ALT and AST concentrations due to feeding CMR. The ALT and AST values are not specific indicators of liver trauma, because both these enzymes are distributed in other tissues, especially muscle (**Joseph, 1999**). Also, these enzymes may be adversely affected by some factors such as muscular

injury, organ rupture, and nutritional status. The reasons for the differences are not currently understood, they were related to differences in stress levels due to the handling and sampling of birds. The values detected are within the normal range observed by **(Ali *et al.*, 2014)**, indicated that the value of ALT and AST for pigeons were 14.81 and 25.67 IU/l. In this study, the plasma uric acid and urea concentrations significantly increased, with the increase of dietary protein in CMR. Uric acid and urea are the main products of the nitrogen metabolism of birds, and uric acid is also the major nitrogenous waste product of birds (**Harr, 2002**). However uric acid metabolism is influenced by the amount and quality of protein in the diet (**Ward *et al.*, 1974)**. The increase of uric acid and urea values in squabs this indicated that birds better utilized CMR. However, uric acid concentrations in the blood reflect the changes in protein utilization and therefore, influenced by nutritional status. This may be due to birds are uricotelic, 60 to 80% of the total excreted nitrogen in birds being in the form of uric acid (**Skadhauge, 1983**). Uric acid concentration has been used as an index of protein catabolism because uric acid is the main end product of nitrogen excretion in birds (**Boismenu *et al.* 1992**). The finding of **Lumeij (1987)** indicated plasma urea (and less clearly plasma creatinine) concentration is a useful variable for detecting renal failure in pigeons, and plasma urea concentration has traditionally been considered as an inappropriate parameter to evaluate renal function in birds. In general, as a matter of fact the values of blood parameters including haematological and biochemical parameters measured at 28 d of age could provide correct diagnosis in different pathological status and most commonly associated with health status (**Norte *et al.*, 2008**). In this context, **Ekunseitan *et al.* (2013)** reported that blood parameters are good indicators of physiological, pathological and nutritional status of an animal and changes in haematological parameters have the potential of being used to elucidate the impact of nutritional factors and additives supplied in diet on any living creature.

Carcass characteristics: It seems clear from data presented in Table 6, squab was slaughtered at about 28 d of age (**Blechman, 2006)**. The present results indicated that the improvement in weight at 28 d of age might be due to the positive impact of CMR on weight and length of digestive tract which increase digestion and the reduction of passage rate of the digesta through the gastrointestinal tract, allowing for better nutrient absorption and utilization resulting in a more efficient use of nutrients from diet lead to improvement in LBW. Also, the improved growth rate is a result from the high percentage of long chain fatty acids and higher contents of triglycerides (**Thacker *et al.*, 1994**), present in CMR formula. This results are consistent with **Azad (2009)** observed that live weight of Gola male and female pigeon were 304.10 and 257.50 g. Conversely, the findings of the present study indicated that there were insignificant differences observed for the most carcass traits, with exception of LBW, spleen, wings and abdominal fat percentages. Fat is predominantly deposited in the abdominal cavity, in the vicinity of the cloaca, and under the skin, and because it is a waste product efforts are made to reduce its content through the use of dietary supplements. The increase in abdominal fat percentage in squabs fed CMR may be due to the effect of low protein and energy ratio, where low ME/CP ratios make squabs fatter. This is associated with an increase in the activity of liver, which may explain the higher abdominal fat percentage. Dressing percentage is a trait of economic importance (**Omojola, 2007**), the high dressing out percent the better in terms of

economic returns. In general our results are agreed with **Hasan *et al.*, (2015)** indicated that dressing percentage, total meat, breast meat, head and gizzard were 62.60, 34.52, 23.63, 3.09 and 1.91% for male pigeon and 56.80, 28.22, 19.45, 4.24 and 2.63% for female respectively. **Ibrahim and Bashrat (2009)** indicated that the overall mean live body weight for squabs was 269.30 g for male *vs*. 200.40g for female, while the overall dressing percentage was 59.03%. Also, **Omojola *et al.* (2012)** found that the dressing percentage was 66.72%, 66.18% and 65.15% for Kura, Jamul and Algardi pigeons. Furthermore, **Abdel-Azeem *et al.* (2007)** indicated that the overall mean of different carcass traits in squabs were 2.32% (liver), 67.79 % (carcass weight percentage), 6.03 % (blood), 7.70% (feather) and 1.95% (gizzard).

Carcass chemical compositions: There is less information about muscle compositions of squabs; however consumers often demand information regarding the nutritive value of squab meat which is very important for human consumption. It should be noted that squab's meat is considered a delicacy and is characterized by high nutritive value, due to high protein content and low cholesterol content (**Pomianowski *et al.*, 2009**). In this context, Chinese people consider the meat of pigeons as having medicinal value (**Hsiung *et al.*, 2005**). Therefore, squab meat can be used as a valuable inclusive component of the human diet, where Egyptians raised pigeon for food (**Levi, 1972)**. In this study, bodies of squabs that were subjected to different CMR had lower moisture content, than squabs fed PCM. The changes in water content were related to the changes in dry matter levels. Converse trend, highest DM % was observed in carcass of squabs fed CMR compared to squabs fed PCM. However, the effect of CMR revealed insignificant effect on CP % and EE% in meat. Also, the cut of breast contains higher content of CP and lower EE than thigh muscle. This finding is agreed with **Suchý *et al.* (2002)** indicated that breast muscles contain higher contents of protein, ash lower contents of dry matter and fat. Also, **Simeonovová (1999**) showed that leg muscles have higher fat content and lower protein content than breast muscles. According to **Díaz *et al.* (2010)** indicated the differences in breast and leg muscles could be attributed to the very structure of these organs, with breast muscles being mostly composed of white fibers, as opposed to drumsticks made up of muscles that contain red fiber shaving different metabolic functions. These results suggested that carcass CP and EE were the limiting factors affecting the compositions of meat (**Snežana *et al.*, 2010**). Protein and fat of muscle tissue are important meat quality parameters and contribute substantially to the nutritional characteristics of meat. There are reports that diet is one of the factors that determine the chemical composition of meat, particularly that of the fat and protein content (**Liu *et al.*, 2006**). Therefore, hand feeding squabs do not adverse effect on meat chemical compositions compared to squabs fed PCM. From all this, it was realized that the composition of pigeon meat reported here is similar to that previously reported by **Morgan (2006)** published that squab usually considered a delicacy; tender, very lean, easily digestible and rich in proteins, minerals and vitamins moist and richer in taste than many commonly consumed poultry meats. Also, **Parkhurst and Mountuey (2004)** reported that pigeon meat is a rich source of protein and other nutrients comparable to that of chicken. They added mean of moisture, ether extract, protein and ash content of pigeon meat were 66.94, 11.90 and 19.69 and 2.35% respectively. In recent study reported by **Apata *et al.* (2015)** indicated that in overall assessment, pigeon meat is favorably comparable to those of other poultry species in terms of quality.

Accordingly, it should be noted that demand for squab is increasing in Egypt, because it is very lean, easily digestible and rich in proteins, minerals and vitamins despite squab is often sold for much higher prices than other poultry species.

GENERAL CONCLUSION AND RECOMMENDATION

Based on the obtained results CMR can be successfully used in hand-feeding of pigeon squabs from 3rd d post hatching without any negative effect on growth rate. One of the benefits of this study was to increase productivity of parent pigeon, because pigeon is a species with a moderate economic produced 14 squabs per year. This is a matter of great concern, if parents did not need to feed their squabs for about 28 d, more eggs would be obtained from each pair of pigeons where, egg laying cycle is initiated after early weaning.

Table (1): Ingredients used in formulating crop milk replacer (CMR) for hand feeding of squabs.

Ingredients (g)	CMR formula*		
	CMR 1	**CMR 2**	**CMR 3**
Soybean full fat (37%)	670	590	430
Gluten (62%)	260	340	500
Fresh egg (12%)	30	30	30
Powder milk (24%)	30	30	30
Sun flower oil	3	3	3
Sodium chloride (NaCl)	1.5	1.5	1.5
Calcium carbonate ($CaCo_3$)	1.5	1.5	1.5
Di-calcium phosphate ($CaHPO_4$)	1.5	1.5	1.5
Brewer Yeast	1.5	1.5	1.5
Mineral and vitamin Pre-mix **	1	1	1
Total (kg)	1.0	1.0	1.0
Calculated analysis:			
Crude protein %	42.03	44.03	48.03
Ether extract%	4.87	4.99	5.07
Metabolizable energy (kcal/kg)	3277.5	3308.7	3371.1
ME/CP ratio	76.67	74.05	69.28
Calcium %	0.30	0.28	0.24
Available phosphorus %	0.12	0.13	0.15
Lysine %	1.64	1.78	1.94
Methionine + cystine %	1.47	1.61	1.85
Chemical analysis:			
Crude protein %	42.14	44.15	48.12
Ether extract %	5.12	5.76	6.06
Ash %	4.02	3.68	3.01

*****CMR=Crop milk replacer

**Mineral and vitamin Pre-mix contains: Vit A 12000 I.U., Vit D3 2000 I.U., Vit E 40 mg, Vit. K 34 mg, Vit. B l 3 mg, Vit. B2 6 mg, Vit. B6 4 mg, Vit. B12 0.03 mg, Niacin 30 mg, Biotin 0.08, mg, Pantothenic acid 12 mg , Folic acid 1.5 mg, Choline chloride 700 mg, Mn 80 mg , Cu 10 mg, Se. 0.2 mg, Fe 40 mg, Zn 70 mg and Co . 0.25mg.

Table (2): Chemical and amino acid compositions of PCM compared to CMR (on DM basis %)

Items	PCM*				CMR		
	At 1 d	**At 7 d**	**At 14 d**	**At 21 d**	**CMR 1**	**CMR 2**	**CMR 3**
Water %	69.3	59.4	67.4	68.2	85	86	88
DM %	30.7	40.6	32.6	31.8	15	14	12
CP %	59.4	61.4	61.9	55.1	42.14	44.15	48.12
EE %	35.9	36.0	35.3	33.6	5.12	5.76	6.06
ASH %	4.8	2.7	2.9	4.9	4.0	3.7	3.0
GE Kcal /g	4.900	4.900	4.900	4.300	-	-	-
ME Kcal/kg	-	-	-	-	3277.5	3308.7	3371.1
Lysine %	5.00	5.89	5.99	5.18	1.50	1.59	1.98
Methionine %	2.80	2.96	3.11	2.90	2.90	2.88	2.87
Cystine %	0.38	0.45	0.56	0.44	0.40	0.39	0.41
Aspartic %	9.69	11.56	12.32	10.02	3.05	3.05	3.33
Therionine %	4.36	5.50	6.11	6.11	1.36	1.21	1.37
Serine %	1.68	1.70	1.87	1.12	1.78	1.61	1.80
Glutamic %	13.32	14.38	14.53	11.63	7.07	6.27	6.57
Proline %	2.98	3.32	3.43	3.02	2.75	2.50	2.50
Glycine %	1.69	1.77	1.79	1.15	1.25	1.15	1.32
Alanine %	1.11	1.18	1.33	1.12	2.68	2.15	2.50
Valine %	4.89	5.87	6.03	5.12	1.95	1.80	1.91
Isoleucine %	4.00	5.12	5.38	4.18	1.95	1.50	1.59
Leucine %	7.13	8.91	9.02	7.15	4.62	3.85	3.70
Tyrosine %	1.09	1.22	1.46	1.02	2.01	1.75	1.74
Phenylalanine %	4.55	5.16	5.22	4.09	2.39	2.08	2.15
Histidine %	1.43	1.52	1.55	1.14	0.98	0.92	1.00
Arginine %	5.06	5.56	5.86	5.42	1.85	1.89	2.15

*PCM= data of pigeon crop milk cited by (**Abdel-Azeem, 2010**).

Table (3): Performance of squabs as affected by hand-feeding CMR diets compared to PCM (Mean ± SE).

Items	Groups				Sig	Overall means
	PCM	CMR 1	CMR 2	CMR 3		
Average body weight at:						
3 day	34.45±2.2	35.58±2.3	36.32±2.0	37.67±2.2	NS	36.01±1.7
7 day	91.97±5.7	82.80±3.7	85.18±4.6	86.69±5.7	NS	86.66±5.8
14 day	182.71±11.9	178.35±13.2	183.74±11.2	186.34±11.1	NS	182.78±4.6
21 day	265.18±19.9	271.66±18.5	277.51±20.2	282.36±19.2	NS	274.18±8.7
28 day	327.87±24.8	348.44±28.2	353.98±24.5	357.31±18.2	NS	346.9±11.5
35 day	333.96±17.7	354.69±20.2	360.28±19.7	364.02±21.8	NS	353.24±11.6
Gain from:						
3-7 day	57.52^{a}±3.4	47.22^{b}±1.5	48.86^{ab}±2.6	49.02^{ab}±3.5	*	50.655±4.8
8-14 day	90.73±6.3	95.55±9.5	98.56±6.8	99.64±5.4	NS	96.12±3.2
15-21 day	82.47±8.0	93.31±5.3	93.76±9.7	96.02±8.2	NS	91.395±9.7
22-28 day	62.70±5.2	76.78±10.1	76.48±4.3	74.96±4.8	NS	72.72±10.0
28-35 day	6.09±1.8	6.25±1.80	6.30±1.91	6.71±1.5	NS	6.34±0.4
Whole gain from (3-28 d)[1]	293.42±10.2	312.86±11.3	317.66±12.6	319.64±13.4	NS	310.90±11.9
Whole mortality rate (%)	2.01±0.0	2.04±0.0	2.030±0.0	2.025±0.0	NS	2.026±0.0
Amount of CMR consumed (mL):						
3-7 day	77.0^{b}±1.4 [2]	87.0^{a}±1.7	87.0^{a}±1.7	87.0^{a}±1.7	*	84.5±1.2
8-14 day	206.0^{b}±2.1	224.0^{a}±2.4	224.0^{a}±2.4	224.0^{a}±2.4	*	219.5±2.1
15-21 day	286.0^{b}±2.8	309.0^{a}±3.1	309.0^{a}±3.1	309.0^{a}±3.1	*	303.2±2.7
22-28 day	356.0^{b}±2.7	387.0^{a}±2.8	387.0^{a}±2.8	387.0^{a}±2.8	*	379.2±3.3
Total feed consumed (3-28 d)	925.0^{b}±9.0	1007.0^{a}±8.0	1007.0^{a}±10.0	1007.0^{a}±10.0	*	986.5±9.3
Feed conversion ratio (g feed/ g gain)	3.15^{a}±0.06	1.09^{b}±0.04	1.08^{b}±0.03	1.07^{b}±0.01	*	1.60±0.4
Protein intake (g)	550.75^{a}±11.1	424.35^{d}±10.1	444.59^{c}±11.2	484.56^{b}±12.3	*	476.0.06±11.2
Energy intake (kcal)	3325.0^{c}±9.4	3300.44^{b}±10.3	3331.86^{b}±10.0	3394.70^{a}±10.2	*	3338.0±9.9
Protein efficiency ratio[3]	0.53^{d}±0.02	0.74^{a} ±0.05	0.72^{b}±0.03	0.66^{c}±0.04	*	0.66±0.04
Energy efficiency ratio[4]	8.83^{b}±1.06	9.48^{a}±1.07	9.53^{a}±1.12	9.42^{a}±1.11	*	9.31±1.09

[a,b,c…]Means within a row that do not share a common superscript are significantly different (P≤0.05)

1- Weight at marketing age

2-Crop milk and grains consumed for control group during growth period

3-Calculated as weight gain divided by protein intake.

4-Calculated as weight gain×100/total ME intake

Table (4): Growth rate of male and female squabs at different period of growth.

Items	Growth rate		Sig.
	Male	Female	
Average body weight at:			
3 days	$40.08^{a}\pm1.1$	$31.92^{b}\pm0.9$	*
7 days	$96.86^{a}\pm2.7$	$76.46^{b}\pm2.1$	*
14 days	$204.20^{a}\pm6.1$	$161.37^{b}\pm4.8$	*
21 days	$308.42^{a}\pm10.2$	$239.94^{b}\pm7.9$	*
28 days	$391.64^{a}\pm12.9$	$302.16^{b}\pm9.9$	*
35 days	$399.96^{a}\pm12.8$	$306.52^{b}\pm9.9$	*
Gain from:			
3-7 days	$56.77^{a}\pm1.8$	$44.53^{b}\pm1.4$	*
8-14 days	$107.33^{a}\pm3.8$	$84.91^{b}\pm3.0$	*
15-21 days	$104.22^{a}\pm4.4$	$78.57^{b}\pm3.3$	*
22-28 days	$83.22^{a}\pm3.7$	$62.22^{b}\pm2.8$	*
29-35 days	$8.34^{a}\pm0.2$	$4.37^{b}\pm0.1$	*
Whole mortality rate (%)	$1.82^{b}\pm0.3$	$2.23^{a}\pm0.3$	*

$^{a,b,c\ldots}$Means within a row that do not share a common superscript are significantly different ($P\leq 0.05$)

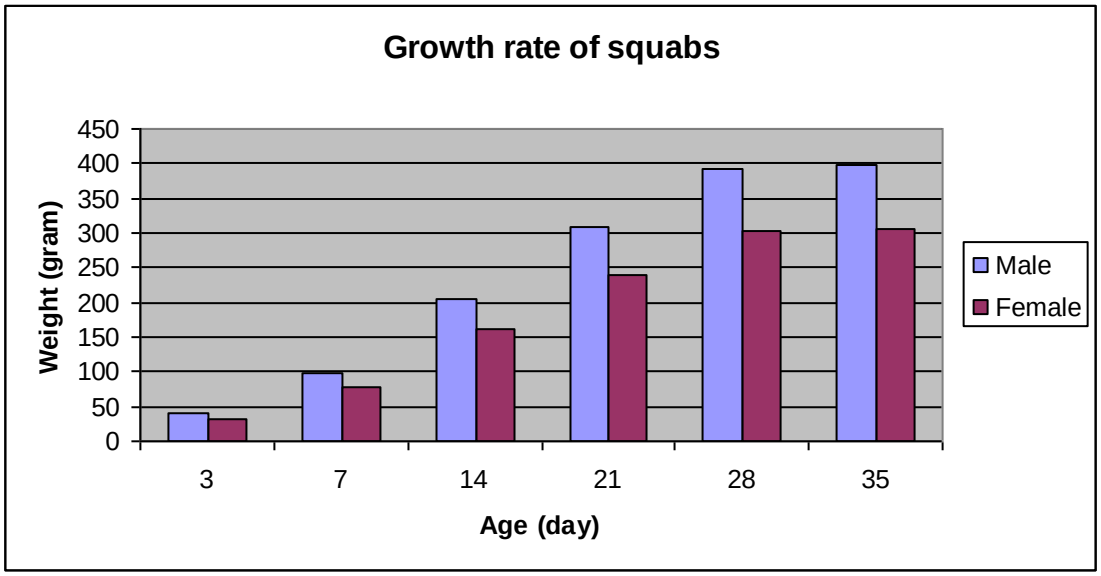

Fig (1): Show the growth rate of male and female squabs during the different period of growth

Table (5): Some blood constituents of squabs at 28 d of age as affected by feeding CMR diets compared to PCM (Means ±SE)

Items	Groups				Sig.	Overall means
	PCM	CMR 1	CMR 2	CMR 3		
Hematological parameters:						
RBCs(cells/10^6×mm^3)[1]	4.65^{d}±0.2	4.76^{c}±0.2	4.89^{b}±0.3	5.23^{a}±0.3	*	4.88±0.3
WBCs (cells/mm^3)[2]	261.33±5.2	261.29±4.1	261.32±5.1	261.30±5.0	NS	261.33±5.0
Differential cell count (%)[3]:	41.14±2.1	41.53±2.1	41.33±2.0	41.42±2.2	NS	41.35±0.9
Hetrophils (%)	35.58±1.9	35.30±1.8	36.50±1.8	36.64±1.9	NS	36.0 ±0.8
Lymphocytes (%)	1.16±0.1	1.18±0.1	1.13±0.1	1.13±0.1	NS	1.15±0.02
H/L ratio [4]	47.53^{d}±0.3	50.00^{c}±0.6	51.88^{b}±0.4	53.38^{a}±0.3	*	50.70±0.5
PCV (%) [5]	13.96^{b}±0.4	14.30^{b}±0.4	14.52^{b}±0.3	15.71^{a}±0.4	*	14.62±0.2
Hemoglobin (g/dl)	88.47±4.6	87.25±4.4	84.52±4.2	79.19±4.2	NS	84.86±2.1
MCV [6]	30.02±1.6	30.04±1.5	29.69±1.5	30.04±1.6	NS	29.95±0.7
MCH [7]	33.93±1.8	34.43±1.8	35.13±1.7	37.93±2.0	NS	35.35±0.9
MCHC [8]	3.00±0.2	3.00±0.2	2.97±0.1	3.00±0.2	NS	2.99±0.1
CI [9]						
Biochemical blood analysis:	4.12^{b}±0.1	4.49^{ab}±0.1	4.53^{a}±0.1	4.65^{a}±0.1	*	4.45±0.1
total plasma protein (g/dl)	1.57±0.0	1.65±0.0	1.67±0.1	1.72±0.1	NS	1.65±0.0
total plasma albumin (g/dl)	2.55^{b}±0.1	2.84^{a}±0.1	2.86^{a}±0.1	2.93^{a}±0.1	*	2.79±0.04
	0.62^{a}±0.1	0.58^{c}±0.1	0.58^{c}±0.0	0.59^{b}±0.1	*	0.59±0.1
	573^{d}±2.8	589^{c}±2.4	601^{b}±2.8	615^{a}±3.3	*	594.5±3.7
total plasma globulin (g/dl)	133.53^{d}±2.7	160.50^{c}±2.4	171.60^{b}±2.6	183.31^{a}±2.6	*	162.23±5.6
	116.66^{d}±1.2	133.33^{c}±1.4	151.11^{b}±1.5	155.55^{a}±1.3	*	139.16±4.7
A/G ratio	36.15^{d}±0.4	44.79^{c}±0.1	49.87^{b}±0.2	53.82^{a}±0.2	*	46.16±2.0
Total plasma lipid (mg/dl)	74.05^{d}±0.3	89.04^{c}±0.2	91.51^{b}±0.3	98.38^{a}±0.3	*	88.24±2.7
Total plasma cholesterol (mg/dl)	23.33^{d}±0.0	26.67^{c}±0.1	30.22^{b}±0.1	31.11^{a}±0.5	*	27.83±0.9
	108.00^{c}±0.4	110.24^{b}±0.4	111.25^{b}±0.3	113.60^{a}±0.4	*	110.77±0.5
Total plasma triglyceride (mg/dl)	8.00^{d}±0.6	11.00^{c}±0.5	15.00^{b}±0.6	20.00^{a}±0.5	*	13.5±1.1
	22.00^{d}±0.6	27.00^{c}±0.4	30.00^{b}±0.4	46.00^{a}±0.6	*	31.25±2.1
High density lipoprotein (HDL) (mg/dl)	0.36^{c}±0.0	0.41^{b}±0.0	0.50^{a}±0.0	0.44^{b}±0.0	*	0.43±0.0
	6.03^{c}±0.2	6.16^{c}±0.1	6.60^{b}±0.8	7.10^{a}±0.1	*	6.47±0.1
Low density lipoprotein (LDL) (mg/dl)	9.07^{b}±0.0	9.86^{a}±0.0	9.86^{a}±0.0	9.32^{a}±0.1	*	9.52±0.1
Very low density lipoprotein(VLDL)(mg/dl)						
Glucose (mg/dl)						
ALT (U/L)						
AST (U/L)						
ALT/AST ratio						
Uric acid (mg/dl)						
Urea (mg/dl)						

[a,b,c…]Means within a row that do not share a common superscript are significantly different ($P \leq 0.05$)

1-(RBCs): Total red blood cells.

2- (WBCs): Total red blood cells

3- Differential count of 100 leukocytes per blood smears.

4-H/L ratio: Hetrophils/Lymphocyte

5-PCV: Packed cell volume

6-MCV: mean corpuscular volume .% Htx10/RBC

7-MCH: mean corpuscular hemoglobin. Hb x10/ RBCs.
8- MCHC: mean corpuscular hemoglobin concentration = Hbx100/%H
9-Color index =Hb% /RBCs

Table (6): Carcass characteristics of squabs at 28 d of age as affected by feeding CMR diets compared to PCM (Means ±SE)

Items	Groups				Sig.	Overall means
	PCM	CMR 1	CMR 2	CMR 3		
Live body weight (g)	330.34^{b}±6.6	342.82^{ab}±4.2	345.36^{ab}±3.7	351.43^{a}±4.8	*	342.48±3.1
Dressing %	52.15±1.0	52.28±0.9	53.24±0.1	52.63±1.0	NS	52.58±0.4
Total edible parts %	71.89±0.8	71.75±0.6	72.82±0.3	71.65±0.6	NS	72.03±0.3
Front part %	36.78±0.5	36.51±0.4	37.05±0.2	36.77±0.4	NS	36.78±0.2
Hind part %	15.37±0.8	15.76±1.0	16.19±0.2	15.86±1.0	NS	15.79±0.4
Liver %	3.45±0.1	3.46±0.1	3.32±0.1	3.36±0.2	NS	3.40±0.6
Heart %	1.04±0.0	1.01±0.0	1.00±0.0	1.00±0.2	NS	1.01±0.1
Spleen %	0.09^{b}±0.1	0.11^{ab}±0.1	0.15^{a}±0.2	0.11^{ab}±0.0	*	0.116±0.0
Gizzard %	2.21±0.4	2.37±0.1	2.43±0.2	2.21±0.0	NS	2.30±0.1
Wings %	6.40^{a}±0.1	6.08^{ab}±0.1	6.10^{ab}±0.2	5.86^{c}±0.1	*	6.11±0.1
Neck %	6.52±0.4	6.42±0.1	6.56±0.1	6.47±0.1	NS	6.49±0.1
Total inedible parts %	28.10±0.8	28.24±0.6	27.18±0.3	28.34±0.6	NS	27.96±0.3
Blood %	3.97±0.2	3.66±0.3	3.41±0.1	3.59±0.3	NS	3.66±0.1
Feather %	11.49±0.3	11.95±0.4	11.53±0.8	12.69±0.4	NS	11.92±0.3
Head %	4.67±0.1	4.19±0.3	4.24±0.3	3.88±0.3	NS	4.25±0.1
Legs %	2.19±0.0	2.20±0.3	2.16±0.1	2.21±0.0	NS	2.19±0.0
Abdominal fat %	0.85^{c}±0.0	0.91^{c}±0.0	1.08^{b}±0.1	1.61^{a}±0.1	*	1.12±0.1
Intestine %	5.77±0.5	6.21±0.3	5.82±0.1	5.94±0.4	NS	5.93±0.2
Intestine length (Cm)	127.40±0.9	128.20±0.5	128.40±0.9	129.00±0.6	NS	128.25±0.4

$^{a,b,c...}$Means within a row that do not share a common superscript are significantly different ($P \leq 0.05$)

Table (7): Carcass chemical composition of squabs at 28 d of age as affected by feeding CMR diets compared to PCM(Means ±SE**)**

Items	Cuts	Groups				Sig.	Overall means
		PCM	CMR 1	CMR 2	CMR 3		
Moisture %	Breast	69.22^{a}±0.4	67.42^{a}±0.6	67.29^{a}±0.8	64.35^{b}±1.1	*	67.07±0.6
	Thigh	64.38±0.4	63.72±0.6	63.40±0.7	62.18±1.1	NS	63.42±0.4
	Whole	66.80^{a}±0.4	65.57^{ab}±0.6	65.35^{ab}±0.8	63.26^{b}±1.1	*	65.24±0.5
Dry matter %	Breast	30.78^{c}±0.2	32.58^{b}±0.3	32.71^{b}±0.4	35.65^{a}±0.6	*	32.93±0.6
	Thigh	35.62^{b}±0.2	36.28^{b}±0.3	36.60^{ab}±0.4	37.82^{a}±0.7	*	36.58±0.3
	whole	33.20^{c}±0.2	34.43^{b}c±0.3	34.65^{b}±0.4	36.73^{a}±0.6	*	34.75±0.4
Crude protein %	Breast	75.36±0.3	75.40±0.24	75.31±0.63	75.48±0.4	NS	75.39±0.2
	Thigh	70.99±0.6	70.98±0.48	71.08±0.63	71.32±0.4	NS	71.09±0.2
	whole	73.01±0.6	73.02±0.46	73.19±0.63	73.40±0.4	NS	73.15±0.2
Ether extract %	Breast	20.11±0.2	20.11±0.1	20.27±0.2	20.35±0.1	NS	20.21±0.1
	Thigh	25.48±0.2	25.49±0.2	25.66±0.2	25.72±0.1	NS	25.59±0.1
	whole	22.79±0.2	22.80±0.1	22.96±0.2	23.03±0.1	NS	22.89±0.1
Ash %	Breast	3.84^{a}±0.0	3.81^{a}±0.0	3.42^{b}±0.0	3.18^{c}±0.0	*	3.56±0.1
	Thigh	2.55^{a}±0.0	2.56^{a}±0.0	2.29^{b}±0.0	2.01^{c}±0.0	*	2.35±0.1
	whole	3.19^{a}±0.0	3.18^{a}±0.0	2.85^{b}±0.0	2.59^{c}±0.0	*	2.95±0.1
NFE %	Breast	1.02^{a}±0.0	1.01^{ab}±0.0	1.00^{ab}±0.0	0.99^{b}±0.0	*	1.00±0.0
	Thigh	0.98^{a}±0.0	0.97^{ab}±0.0	0.97^{ab}±0.0	0.95^{b}±0.0	*	0.96±0.0
	whole	1.00^{a}±0.0	0.99^{ab}±0.0	0.98^{ab}±0.0	0.97^{b}±0.0	*	0.98±0.0

a,b,c…Means within a row that do not share a common superscript are significantly different (P≤ 0.05)

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الملخص العربي

الفطام المبكر لزغاليل الحمام

عبد العظيم فهمي عبد العظيم، عبدالهادى عامر عامر ، طريف عبدالعزيز شما ، وليد عبدالمعز عباس

قسم الإنتاج الحيواني - كلية الزراعة – جامعة الأزهر - مدينة نصر – القاهرة - مصر

أجريت هذه الدراسة بهدف تحسين الآداء التناسلي و زيادة العائد الانتاجى من الحمام وذلك بفطام الزغاليل المبكر في اليوم الثالث من الفقس. حيث أن الآباء إذا لم تكن في حاجة لتغذية صغارها لمدة ٢٨ يوم فإن انتاج البيض يزيد لكل زوج وذلك باعاده الدوره التناسليه بعد فطام الزغاليل. في الأيام الثلاثة الأولي يكون من الصعب جدا فطام الزغاليل لأنها تعتمد كليا علي اللبن الحويصلي للحمام و الذي يحتوي علي الجلوبيولينات المناعية و مركبات أخري غير معروفة لازمه للحياه. وفى نهاية اليوم الثالث من التحضين يمكن عمل البديل الصناعي للبن الحمام و تغذية الزغاليل عليه بنجاح حتي نهاية فترة النمو. في هذه التجربة تم اخذ عدد ١٣٥ زغلول في نهاية اليوم الثالث من التحضين بمتوسط وزن (٣٦.01 جم± 1.7) حيث تم تقسيم هذا العدد عشوائيا إلي 3 مجاميع بكل مجموعة ٤٥ زغلول مقسمة إلي ثلاثة مكررات بكل مكررة ١٥ زغلول. وتمت مقارنه المجموعات الثلاثه السابقه بمجموعه الكنترول والتى غذيت بواسطه الاباء وكان عدد الزغاليل فى هذه المجموعه ٤٥ زغلول. غذيت الثلاث مجموعات على ثلاث بدائل للبن الصناعى والذى احتوى على ٤٢,١٤، ٤٤,١٥ ، ٤٨,١٢ % بروتين خام، ٣٢٢٧,٥ ، ٣٣٠٨,٧ ، ٣٣٧١,١ كيلو كالورى/كجم غذاء .وغذيت الزغاليل على بديل اللبن الصناعي المكون أساسا من الصويا المعاملة حراريا مع إضافة الجلوتين و البيض و اللبن المجفف والخميرة و مخلوط الأملاح و الفيتامينات مع اضافه الزيت الى بديل اللبن الصناعى. تم إضافة البيض و اللبن المجفف لمضاعفة القيمة الغذائية. في المرحلة الأولي من الفطام (٣ – ١٤يوم) غذيت الزغاليل علي اللبن الصناعي مخففا بنسبة ١٤% غذاء مجفف و ٨٦% ماء مقطر بينما فى المرحلة الثانية (١٥ – ٢٨ يوم) كانت النسبة ٢٠ % غذاء مجفف و ٨٠ % ماء مقطر. تم تسجيل معدل النمو اليومي و الغذاء المستهلك و مقارنتها بالزغاليل التي تركت مع آبائها (الكنترول) .معدل النمو في الزغاليل لم يتأثر معنويا بالفطام المبكر مقارنة بالزغاليل التي تركت مع آبائها. كان أعلي معدل للزيادة الوزنية في الأسبوع الثاني و يقل بالتدريج حيث يكون معدل النموفى الاسبوع الخامس منعدم تقريبا . لوحظت فروق معنوية في معظم قياسات الدم للزغاليل الناتجة من الفطام المبكر بينما لم تكن هناك فروق معنوية في معظم قياسات الذبيحة باستثناء وزن الجسم و الطحال و الأجنحة و دهون البطن. أيضا لم تلاحظ فروق معنوية في نسبة البروتين الخام و الدهن الخام في الذبيحة نتيجة للتغذية علي البديل الصناعي للبن. عموما أشارت النتائج إلي أن الفطام المبكر للزغاليل هو طريقة جديدة لزيادة الإنتاج من قطيع الآباء و زيادة عدد الزغاليل المنتجة سنويا ويمكن ان تفطم زغاليل الحمام بنجاح بتغذيتها على بديل اللبن الحويصلي مما يعظم من الناحيه الإقتصادية بزيادة عدد الزغاليل المنتجة سنويا و زيادة الخصوبة.