Sexing on a Day-old Chick of Gold Arabic chicken (*Gallus turcicus*) using Feather Sexing Method

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1 ABSTRACT

Gold Arabic Chickens (*Gallus turcicus*) are local laying chicken developed in Indonesia. Early chick sexing is important in production management since it is laying hens needed as the egg breeders. The most common manual sexing method is vent sexing with high accuracy, despite its various requirements and weaknesses. It is found that in Arabic chickens, no sexing method is applicable because vent sexing method is very difficult and feather sexing method has never been tested. This study aimed to estimate a *Day-old Chick* (DOC) sexing of gold Arabic chickens using feather sexing method (wing feathers and plumage colour), and to determine its accuracy as an alternative method without using special tools and can be done visually. This research was conducted on 128 DOC of Gold Arabic chickens, which were sexed using three different feather-sexing methods, such as (1) length difference on primary and secondary feathers, (2) length difference on primary and covert feathers, (3) the difference in Plumage colour pattern from the dorsal of the head to the back. The data collected were analysed descriptively. Sex identification was proven using gonad observation through necropsy. The findings (percentage of accuracy) are method (1) 80.47%; method (2) 64.84%; method (3) 61.72%. This indicates that the differences in primary and secondary feather growth have the highest accuracy for sex prediction; however, development is needed to improve its accuracy.

2 INTRODUCTION

Arabic chicken is one of the local laying hens and are widely developed in Indonesia due to their high egg production compared to the others local chickens. Arabic Gold Chicken (*Gallus turcicus*) is characterized by its reddish-brown body feather from the neck to the head. Plumage colour on the body to the tail is reddish-brown with black lines (Indra *et al.*, 2003). The males have thicker feathers along the neck, lower back, and tail, while in females, the feathers are thicker only in the neck area. Early identification of sex accuracy on the first day of hatching (a day-old chick) contributes to the economy and efficiency in poultry industry management (Abdellatif, 2001; Genchave *et al.*, 2008). In program breeding Arabian Golden chickens, the *Day-old Chick* (DOC) sex must be separated immediately after hatching where females are aimed to produce eggs, and the male DOC will be used as by-products and be culled as they are not economical (Galli *et al.*, 2018). DOC sexing is a technique for identifying and determining the sex of day-old chicks, and distinguishing between male and

female sexes. DOC sexing is performed after hatching by an expert or professional called a chick sexer. Sexing in determining the chickens' sex is different from mammals, where chicken genital organs are located inside the abdominal cavity and not visible from the outside. DOC sexing can be performed using other external characteristics showing sexual dimorphism between males and females (Roiter *et al*., 2011). Current methods applied in DOC sexing are vent (cloacal) sexing and feather sexing. Vent sexing is a conventional method mostly applied to determine the DOC sex, while feather sexing makes use of primary and secondary wing feather sexing methods (Pastrana *et al*., 2019). Both methods have strengths and weaknesses. The sexing method has been widely applied to broilers and layers (Yousaf, 2016). Local chickens sexing has not been developed, and most, Arabic chicken farms sell un sexed DOC. Farms selling sexed DOC generally implement the vent sexing method conducted by trained personnel. The vent sexing method must be conducted using hand by carefully opening the cloaca small genital bump indicates a male, on the other hand, no small bump (smooth genital fold) means the chick is female. Some female DOCs have bumps with a smaller size than the male DOCs. Several chicken breeds have been characterized by this method (Ellendorff and Klein, 2003). Weaknesses in vent sexing method are : (1) the sexer must be quick, gentle and have sharp eyes to see the chick's cloaca, as it is very similar both in males and females, (2) requires special lighting or magnifying glass to help to clarify the part of the chick's cloaca; (3) allows cross-contamination, as when it is opened, the cloaca fluid or faeces will come out from the cloaca which may contain pathogenic bacteria or viruses that can transmit from one chick to another ; (4) may increase the chick mortality rate up to 1,0% (Phelps, *et al*., 2003); (5) requires facilities, time, training and specialized expertise that might increase production costs (Idahor, *et al*., 2015; Pastrana *et al*., 2019). An alternative method for sexing is feather sexing. It is a method of determining sex based on feathers' growth on the wing. This method is based on the growth rate of the outer edge of the wing's feathers, primary feather, secondary feather, and covert feather; or colour pattern (plumage colour) in the first day after hatching (Gryzinska *et al*., 2014) This method has high accuracy (98%) in broiler chickens, where detailed genetic studies have been carried out to obtain gene coding traits growth in primary and covert feathers (Roiter *et al*., 2011). However, this method has not been widely reported in local chickens in Indonesia, as not many studies have been conducted in genetic traits. Based on the weaknesses and difficulties in vent sexing, this research attempts to find alternative sexing methods for practical applications. Feather sexing is more comfortable and does not require particular expertise, with minimum complexity. However, for local chickens in Indonesia, particularly gold Arabic chickens, there have not been many types of research conducted on the feather sexing method, as the characteristics are very different from purebred chickens, and there is no evidence whether the Arabian chicken feather DOC has sexual dimorphism. This study aimed to estimate the DOC sex of gold Arabic chickens using feather sexing method (wing feathers and plumage colour), and to determine its accuracy, thus allowing practical method for sexing day-old chicks.

3 MATERIALS AND METHODS

This research used 128 DOC Arabic chicken (*Gallus turcicus*) because of natural mating. The eggs were collected, while the hatching process was conducted in the Poultry Installation of Malang Agricultural Development Polytechnic. The sex identification of Gold Arabic chicks was conducted during one day (24 hours) of hatching based on three sexing methods. The sex identification was conducted using gonad observation (testes or ovaries) after the chicks in necropsy, and the abdominal part was hatched (Dakpogan *et al*., 2012). The three sexing methods are listed in Table 1.

Table 1: Three methods of feather sexing in Gold Arabic chickens

Method	sexing method	Characteristics of male predicted chicks	Characteristics of female predicted chicks	References
1	Length difference between primary and secondary feathers on wing feathers	Primary and secondary feathers have almost the same length	Primary feather is longer than secondary feather	Dakpogan *et al.,* (2012)
2	Length difference between primary and convert feathers on wing feathers	Primary and covert feathers have almost the same length	Primary is longer than covert feather	Kalleta and Redmann, (2008)
3	Colour pattern or Plumage colour on the dorsal (from head, neck to back)	There is no feather line colour in Plumage from the head to back area and looks darker	Plumage from head to back area forms striped and lighter feather colour e	Abellatif (2001); Genchev, *et al.,* (2008); Kalleta and Redmann, (2008)

Primary-secondary feather length and primary-covert feather length were observed visually, to ensure the length of the feather and were captured by stereo microscopy. The obtained data were analysed descriptively, while the percentage of accurate sexing success after sex confirmation was calculated using gonad observation (Kusumawati *et al.*, 2016). The percentage is related to the accuracy of each sexing method. The percentage of accuracy on sex identification method was calculated using the following formula:

$$\text{Percentage of accuracy} = \frac{\text{sum of sexing results in accordance with gonad observation}}{\text{The number of DOC samples}} \times 100\%$$

4 RESULTS AND DISCUSSIONS

The results of sex prediction on DOC Gold Arabic chickens using three different sexing methods are as follows.

4.1 Method 1: DOC sexing based on length difference between primary and secondary feather: Method 1 is sexing the DOC of the Gold Arabic chicken using wing feather measurements on length difference between primary and secondary feathers (Durmus *et al.*, 2010). The results showed that this method had an accuracy of 80.47%, with an error rate of 19.3%. This method is based on research conducted by Dakpogan *et al.*, (2012 in distinguishing primary and secondary feather lengths) on chicken DOC with silky, curly (frizzled), and healthy feathers that are maintained in free-range (extensively).

Table 2: The accuracy of feather sexing using three different sexing methods.

Prediction Result	method 1		method 2		method 3	
	Male	Female	male	female	male	female
Number of DOC samples being sexed (based on sex)	59	69	56	72	56	72
Number of DOC that does not match with gonad observation	12	13	21	24	23	26
Number of DOC that matches with gonad observation	47	56	35	48	33	46
The accuracy based on sex (%)	79.66	81.16	62.50	66.67	58.93	63.89
The total number of DOC that matches with the gonad observation	103		83		79	
Total accuracy (%)	80.47		64.84		61.72	

This method explained that there are three characters in distinguishing wing feathers in identifying sex with scoring, such as (1) secondary wing feathers were longer than primary wing feathers and resulting in the accuracy of 91.3% on male and 8.7% on a female; (2) primary wing feathers had the same length as secondary wing feathers with the accuracy of 73.3% on male and 26.6% on the female; (3) secondary wing feathers were shorter than primary wing feathers with the accuracy of female 81.8% and males 18.1%. The length difference in primary and secondary feathers is categorized as post-hatched sexual dimorphism that acts as a trait controlled by synergistic action between somatic sex from feather cells and gonads during hormone release (Dakpogan *et al.*, 2012). Results of the study showed that none of a day-old chick characterized as primary feathers that were shorter than secondary feathers, and hence, the feather sex was scored as 2 and 3. The accuracy of the sex prediction based on method one is listed in table 3. The primary feathers had almost the same length as a secondary feather, and not all of them were identified as male. The accuracy was 79.66% for males and 20.34% for females. This percentage is lower than Dakpogan *et al.* (2012) are. The primary feathers were longer than the secondary feathers with an accuracy of 81.16% for females and 18.84% for males.

Table 3: The accuracy of sexing method 1 on DOC of Gold Arabic chicken

Characteristics of wing feathers	Male DOC		Female DOC	
	Number	(%)	Number	(%)
The primary feathers had almost the same length as secondary feathers	47	79.66	12	20.34
The primary feathers were longer than the secondary feathers	13	18.84	56	81.16

The primary and secondary feathers from sexing method one are described as follows:

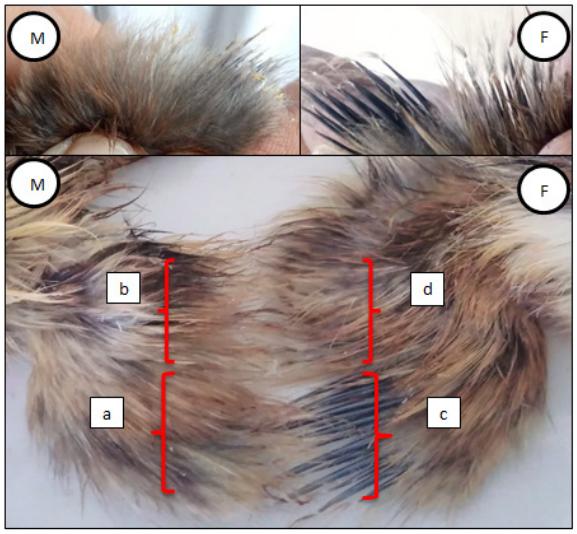

Figure 1: Feather Sexing on DOC of Gold Arabic chickens using method 1: differences in primary and secondary feathers (a, c: primary feathers: b, d: secondary feathers, M: male); F: female (female). The left figure (M) shows almost the same primary and secondary feathers, which identified as male, in the right image (F), the primary feathers, are longer than the secondary feathers, which identified as female.

4.2. Method 2: DOC sexing based on the length of primary and covert feathers: Method 2 is sexing the DOC of golden Arabic chicken using wing feathers by measuring the length between primary and covert feathers. This method has been applied in leghorn chicks, whose wing feathers are slow and fast feathering. The sex is determined based on the characteristics of chicken feather's growth, both slow and fast feathering, as widely used in poultry farms in America. For purebred chickens, it has been identified that controlling feather growth is related to sex, and slow-feathering is more dominant than fast-feathering (Kalleta and Redmann, 2008). Based on this, female chickens are considered as fast feathering, while male chickens are slow feathering. In leghorn chicken, the difference in feather length is seen a day after hatching. The primary feathers and covert (upper wing feathers) on wingtips are identified from the characteristics of wing feathers. If the primary feathers are longer than the covert feathers, the chicks are identified as female, if the primary feathers and coverts have the same length or the covert feathers are longer than the primary feathers, the chicks are identified as male. This feather sexing is very easy to do, and very popular in several strains of large hybrid chickens, despite its unlikeliness to apply to all types of chickens, as this method is merely applied for certain strains of broiler chickens. Autosexing based on the feathers of a day-old chick is widely applied in broiler poultry farms. This method utilizes the dominant gene linked to the Z gene and K gene, which regulate the speed of feather growth. The encoding genes of slow (K) and fast (k) feather growth traits are used for autosexing broiler breeding (Aksoy *et al.*, 2002; Roiter *et al.*, 2011). Nandi *et al.* (2003) indicate that this feather sexing method can only determine the sex of a few chickens because of the cross-breeding process. There has been no report related to the encoding gene for Arabic chickens related to primary and covert feathers' growth. There has been no report regarding feather sexing in local Indonesian chickens with these characteristics, as there is no identification yet on sex-linked genes that are related to the nature of feather growth. The golden Arabic chick sexing using this method yields an accuracy of 64.84%, while the inaccuracy is 35.16%. The accuracy of this method is lower than method 1.

Table 3: The accuracy of feather sexing method 2 on a Day-old chick of Gold Arabic chicken

The characteristics of wing feathers	Male DOC		Female DOC	
	Number	(%)		Number
The primary and covert feathers had almost the same length	36	64.29	20	35.71
The primary feathers were longer than the covert feathers	25	34.72	47	65.28

The primary feather and covert of a day-old chick of Gold Arabic chicken are described as follows.

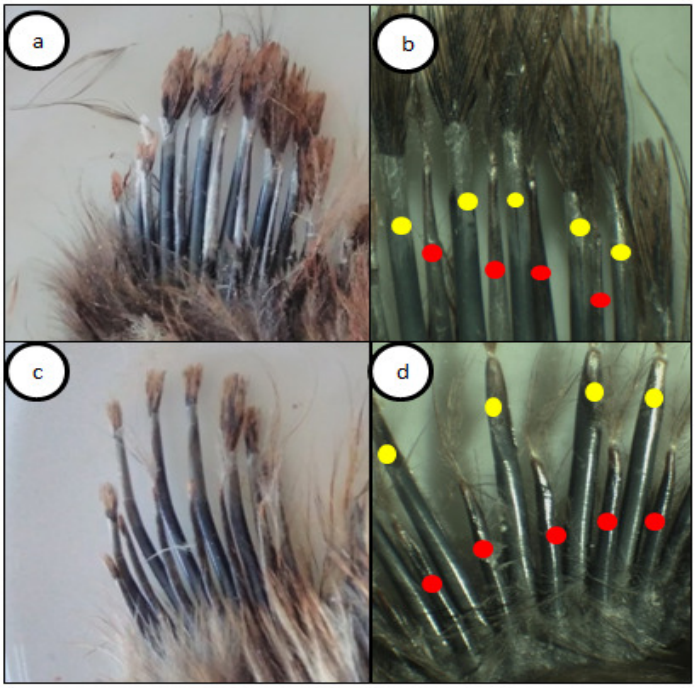

Figure 3: Feather Sexing Method 2 on a day-old-chick of Gold Arabic chickens (a, b: primary feathers with almost the same length as the covert feathers are considered as male: c, d: the primary feathers that are longer than covert feathers are considered as female; : primary feather; : covert feather)

4.3 Method 3: DOC sexing based on plumage colour on the dorsal of the head to the back: The method 3 of sexing is aimed at distinguishing the DOC of golden Arabic chickens based on the feather colour patterns called plumage colours. The plumage colour method is applied to see the colour of the feather on the dorsal of the head, neck, and back (Kalleta and Redmann, 2008). Sexing using the plumage colour in chicken layers acquires high accuracy. Some hybrid strains carry different sex-related traits when hatching, that are the colour of feathers. The gold/silver genes (Ss) as carriers of the feather colour traits, allow sexing plumage colour to be applied. The chicken layer between silver females and golden males will produce golden females and silver males (lighter) (Kalleta and Redmann, 2008). The sexing method using plumage colour on laying hens was conducted by looking at the sexual dimorphism during DOC and the colour of the dorsal body. The results show that the male colour was lighter, while the female colour was dark golden. There has been no report on free-range chickens in Indonesia, whether the sexual dimorphism can be identified from the feathers' colour patterns since the first day of hatching, particularly the Gold Arabic chickens, Hence in this study, sexing on DOC of Gold Arabic chicken is limited to the prediction of

colour patterns on the dorsal of the head to the back. The accuracy of the sexing method using plumage colour was the lowest compared to other methods (61.72%), with sexing error 38.28%. Further study must be conducted on this method, in terms of Arabic chickens' sexual dimorphism, using secondary characteristics on feather colour patterns, as the colour patterns of DOC of Gold Arabic chicken feathers vary greatly.

Overview of feather colour patterns on DOC of Gold Arabic chickens are as follows:

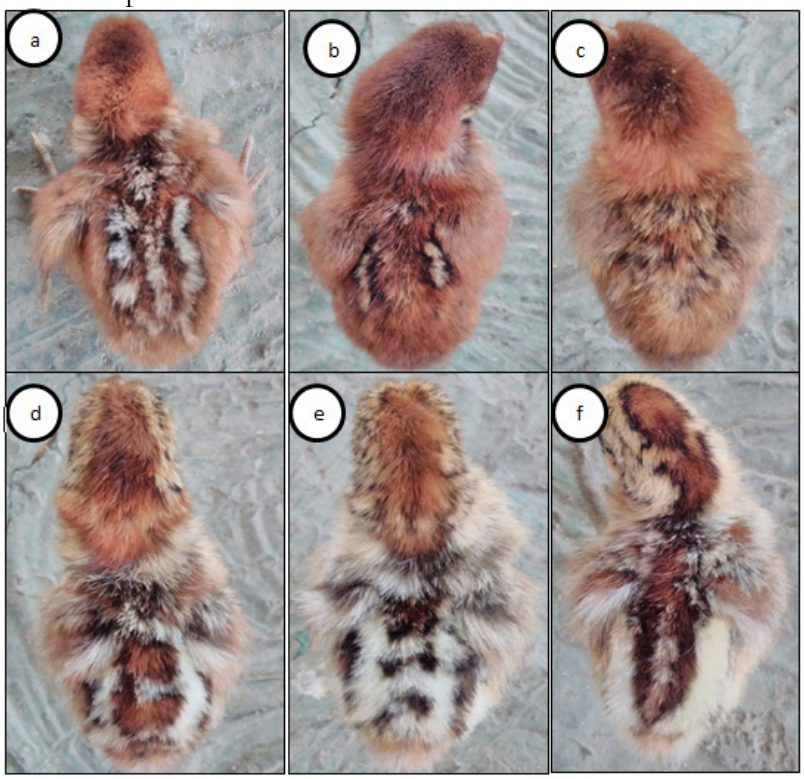

Figure 4: Plumage colour on DOC of Gold Arabic chicken (a, b, c, the colour tends to be darker with little or no stripes on the back (male); d, e, and f colours tend to be whiter with stripes (female)

The colours on DOC feathers in Gold Arabic chickens are a mixture of beige (brownish white) and brown colour, along with lines (strips) with varying distances and sometimes without patterns. The pictures show differences in the colour of the feather pattern on the dorsal of the head to the back. Figure a shows no stripes on the head, no back lines, while the colours tend to be more brown (dark). Figure b: no stripes from head to back, while the back shows thin strips, and the colours tend to be more brown (dark). Figure c: no stripes from the head to the back. Figures d and e: irregular line patterns on the head and back feathers and images e tend to be whiter. Figure f: stripes from the neck to the back. Sex prediction is based on the colour of the feathers, if the DOC is characterized as in pictures a, b, and c, the chicks are considered as male, if the DOC shows colour patterns as found in images d, e and f, the chicks are considered as female. The accuracy of this prediction is proven using gonad observation as shown in Table 3.

Table 3: The accuracy of feather sexing method 3.

The characteristics of plumage colour	Male DOC		Female DOC	
	Number	(%)	Number	(%)
The feathers on the head to back area had little or no colour pattern and / or a darker brown	35	59.32	24	40.68
The feathers in the head to the back area had colour pattern and stripes and or whiter colours (lighter)	27	39.13	42	60.87

This plumage colour method has been applied to the Manchurian Golden quail during hatching by identifying the colour of the feather on the back as it is challenging to apply the vent method from Japan. However, the colour pattern of the feathers on Manchurian Golden quail have not shown any differences in male and female during the hatching. Hence, the sexual dimorphism of males and females with Plumage Colour in quails is conducted 14 days after hatching with an accuracy of 91-94.1% using colour pattern identification in the ventral neck (Genchev *et al*., 2008). Feather colour sexing is easier than vent sexing. However, the accuracy of feather colour sexing in DOC of Gold Arabic chickens is relatively low. Research conducted by Abdellatif (2001) in which applying sex coloration of feathers in Dandarawi Egyptian, chickens show 80.02% of accuracy in male DOC and 92.42% in female DOC. The characteristics of genes that control the colour and feather growth rates open up vast opportunities in poultry production and improve poultry separation technology according to sex and sexing accuracy in poultry (Roite *et al*., 2011). However, the same accuracy has not been revealed in Gold Arabic chickens, and the genetic makeup in Arabian golden chickens does not have certain similarities with other chickens in terms of the feather colour. Further study must be conducted on genes related to the feather colour of Gold Arabic chickens to identify the sexual dimorphism in determining DOC sex with higher accuracy. At a glance, the DOC of Gold Arabic chickens show colour patterns on the back, which are almost the same as chicken. However, accuracy is needed in order to find the differences to be related to sexual dimorphism between males or females. It is concluded that feather sexing method can be applied to identify DOC sex in Arabic gold chickens despite its varying and lower accuracy percentage compared to the sexing method conducted in the previous broiler studies. The primary and secondary feather length difference method is found to have the highest level of accuracy (80.47%). Further study is needed regarding the genetic traceability on golden Arabic chickens and the possibility of increasing the accuracy of the feather sexing method in gold Arabic chickens related to genes carrying the trait of feather growth that is sexually linked.

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