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*Full Length Research Paper*

# Enhancing poultry carcass evaluation: The role of modified skin slice and subcutaneous fat in predicting lean meat and fat content

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**A method for obtaining a modified skin slice with subcutaneous fat in different poultry species, including chickens, ducks, geese and turkeys, was proposed in the study. The weight of the modified skin slice was highly correlated with the total content of subcutaneous and intermuscular fat, including skin, in the carcass. Carcass weight without the modified slice was found to be a good indicator of total lean meat content. The derived simple regression equations for predicting the content of lean meat and fat with skin in the carcass, with the above traits as independent variables, were characterized by very small standard errors of the estimate.**

**Key words:** Skin slice, poultry, carcass, fatness, prediction.

## INTRODUCTION

An increase in per capita income and consumer awareness in developed countries is followed by a change in consumer preferences regarding poultry meat quality. Consumers prefer carcasses characterized by high meatiness and low fatness. Poultry species as well as birds of the same species differ considerably with respect to carcass characteristics. In ducks and geese, the relatively high carcass fat content is determined by genetic and environmental factors, including the feeding regime which affects fat deposition rate. There has also been a steady increase in carcass fat content in broiler chickens, as pointed out by Leenstra (1986) over twenty years ago. It seems to result from intensive feeding and selection for high body weight gains. Inadequate nutrition can lead to a significant increase in carcass fat content also in turkeys. Therefore attempts are made to improve both the genotypes in pedigree flocks and management conditions, to produce high-quality carcasses. Birds used in such experiments should be evaluated with respect to carcass meatiness and fatness. Detailed dissection is the most accurate method to determine carcass tissue composition - the carcass is divided into parts, which are then dissected into lean meat, fat with skin and bones (Haghan and Spindler, 2002; Ziołecki and Doruchowski, 1989). However, in addition to being laborious, time-consuming and expensive, this method reduces the processing suitability of the raw material. The chemical composition of the whole carcass is also difficult to determine (Leeson and Summers, 1980; Walters et al., 1994), which is why simpler and equally effective assistant traits for predicting carcass meatiness and fatness in poultry are continuously searched for.

Numerous studies have been conducted to date to determine whether selected traits, measured *in vivo* and postmortem, can be used to estimate the lean meat and fat content of poultry carcasses. It was found that breast muscle thickness (Bochno et al., 2000; Pingel and Heimpold, 1983) and breastbone crest length (Canope et

**Table 1.** Coefficients of simple correlation (r) between selected traits and the content of lean meat (Y) or skin with fat (U) in poultry carcasses (Bochno et al., 2004, 2005, 2007a, b).

| Specification | Symbols | Sex | Chickens | | Ducks | | Geese | | Turkeys | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Y | U | Y | U | Y | U | Y | U |
| Body weight before slaughter | | ♂ | 0.970 | 0.838 | 0.695 | 0.686 | 0.857 | 0.822 | 0.976 | 0.765 |
| | | ♀ | 0.845 | 0.819 | 0.668 | 0.663 | 0.816 | 0.798 | 0.949 | 0.525 |
| Weight of: whole carcass | | ♂ | 0.985 | 0.761 | 0.686 | 0.774 | 0.899 | 0.851 | 0.977 | 0.753 |
| | | ♀ | 0.907 | 0.681 | 0.622 | 0.736 | 0.877 | 0,812 | 0.947 | 0.532 |
| Breast muscles | | ♂ | 0.962 | 0.685 | 0.815 | 0.476 | 0.881 | 0.567 | 0.947 | 0.640 |
| | | ♀ | 0.908 | 0.571 | 0.713 | 0.334 | 0.906 | 0.519 | 0.886 | 0.264 |
| Leg muscles | | ♂ | 0.962 | 0.752 | 0.694 | 0.299 | 0.853 | 0.476 | 0.950 | 0.592 |
| | | ♀ | 0.921 | 0.704 | 0.691 | 0.355 | 0.883 | 0.306 | 0.886 | 0.205 |
| Abdominal fat | | ♂ | 0.257 | 0.630 | -0.197 | 0.785 | 0.367 | 0.862 | 0.506 | 0.472 |
| | | ♀ | 0.200 | 0.533 | -0.274 | 0.807 | 0.324 | 0.910 | 0.160 | 0.657 |
| Weight of carcass without The skin slice, forewings and wingtips | $X_1$ | ♂ | 0.989 | 0.801 | 0.968 | 0.548 | 0.978 | 0.553 | 0.992 | 0.641 |
| | | ♀ | 0.990 | 0.725 | 0.962 | 0.371 | 0.991 | 0.499 | 0.981 | 0.367 |
| Weight of modified skin slice | $X_2$ | ♂ | 0.758 | 0.998 | 0.581 | 0.990 | 0.540 | 0.998 | 0.667 | 0.995 |
| | | ♀ | 0.688 | 0.995 | 0.302 | 0.994 | 0.417 | 0,997 | 0.275 | 0.991 |

al., 1997; Rymkiewisz -Schymczyk and Szwaczkowski, 2004), measured in live birds, are good indicators of poultry carcass meatiness. However, there are no reliable *in vivo* indicators of carcass fatness. During a postmortem analysis, carcass meatiness is usually evaluated based on the weight of breast, thigh, and drumstick muscles, whereas fatness is estimated based on abdominal fat weight.

The suitability of skin with subcutaneous fat for predicting carcass fat content has also been analyzed. Castaing et al. (1997) assessed a technique for estimating the degree of turkey carcass fatness based on weighing a triangular section of skin plus subcutaneous adipose tissue from the iliofemoral apophyses to the junction of the sacral and coccygeal vertebrae (r = 0.70 in males and r = 0.82 in females). Walters et al. (1994) noted a correlation between the percentage of breast skin with fat and the percentage content of whole carcass fat in Pekin ducks (r = 0.58 – 0.76). Ziołecki and Konieczny (1983) observed a significant correlation between the percentage content of fat in the triangular section of back skin and the percentage content of whole carcass fat in Pekin ducks (r = 0.66). Nevertheless, sections of skin with subcutaneous fat cannot be considered as good indicators of carcass fat content due to relatively low values of the above correlation coefficients.

In “Methods for Evaluating the Slaughter Value of Poultry”, Ziołecki and Doruchowski (1989) used the weight of a skin slice with subcutaneous fat (skin plus subcutaneous fat from the entire body surface area excluding the wings) as an indicator of carcass fatness.However, in the method developed by Ziołecki and Doruchowski (1989) the line separating the skin that covers the wings from the skin that covers the remaining parts of the carcass, referred to as the skin slice, is described imprecisely, which is why the results obtained by other authors using this method could vary widely. In order to eliminate the above imprecision, Bochno et al. (2004, 2005, 2007a, b) made an attempt to modify the method for obtaining the skin slice. The results of follow-up research were highly satisfactory (Tables 1 and 2).

The objective of this review paper was to presenta method for obtaining a modified skin slice with subcutaneous fat as an indicator of fat content in poultry carcasses. Carcass weight without the

**Table 2.** Simple regression equations for estimating the content of lean meat (Ŷ,g) and skin with subcutaneous and intermuscular fat (Û,g) in the carcass and the standard errors of the estimate $S_{y/u}$.

| S/N | Species | Sex | Regression equation | $S_{y/u}$ | References |
|---|---|---|---|---|---|
| 1 | Chickens | ♂♀ | $\hat{Y} = 0.7672\ X_1 + 10.4$ | 17.6 | Bochno et al. (2004) |
| 2 | | | $\hat{U} = 1.1158\ X_2 + 6.7$ | 3.9 | |
| 3 | Ducks | ♂♀ | $\hat{Y} = 0.6915\ X_1 - 0.77$ | 21.6 | Bochno et al. (2007a) |
| 4 | | | $\hat{U} = 1.0560\ X_2 + 53.3$ | 10.6 | |
| 5 | Geese | ♂♀ | $\hat{Y} = 0.755\ X_1 - 27.8$ | 26.3 | Bochno et al. (2007b) |
| 6 | | | $\hat{U} = 1.070\ X_2 + 19.5$ | 11.4 | |
| 7 | Turkeys | ♂ | $\hat{Y} = 0.9400\ X_1 - 1151$ | 152 | Bochno et al. (2005) |
| 8 | | ♂ | $\hat{U} = 1.0529\ X_2 + 209.8$ | 30.4 | |
| 9 | | ♀ | $\hat{Y} = 0.905\ X_1 - 524.5$ | 95.6 | |
| 10 | | ♀ | $\hat{U} = 1.1261\ X_2 + 47.7$ | 20.2 | |

$X_1$ - weight of without the skin slice, forewings and wingtips, $X_2$ - weight of modified skin slice.

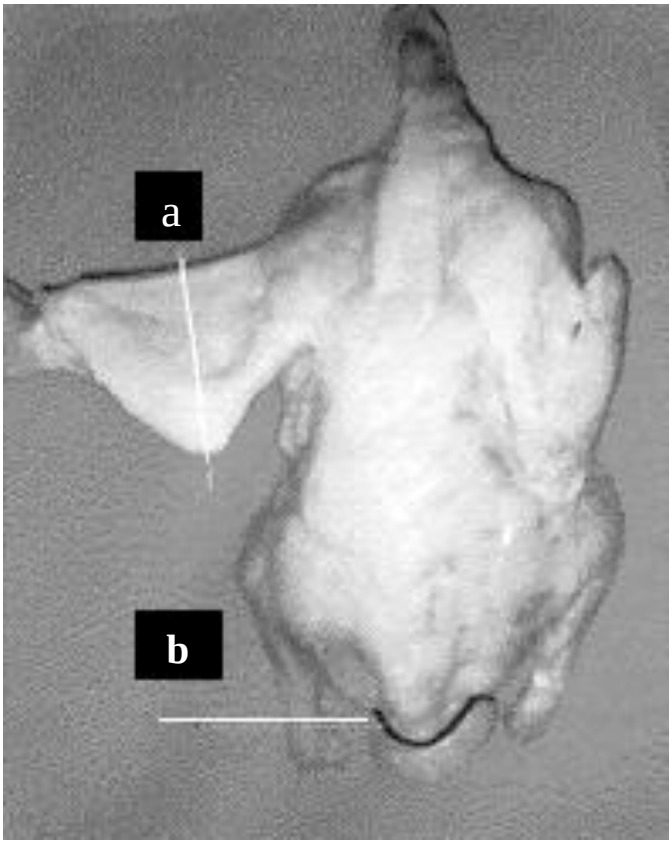


**Figure 1.** Line separating the forearm and wingtip from the shoulder (a) and line separating the rump skin from the skin slice (b); turkey carcass.

modified skin slice was used to predict the total lean meat content of the carcass in broiler chickens, ducks, geese and turkeys.

**Method for obtaining a modified skin slice with subcutaneous fat**

Following a preliminary analysis, the skin slice described by Ziołecki and Doruchowski (1989) was expanded to include the skin covering part of the wings. The imprecisely determined cutting line was shifted from the region of the shoulder joint to the elbow joint (connecting the humerus, the ulna and the radius).

**Procedure**

A chilled carcass was placed on the table, back side up. One of the wings was pulled away from the body, and the forearm with the wingtip was separated from the carcass with a knife, so as to divide the angle between the humerus, the ulna and the radius into two equal parts (Figure 1a). The procedure was repeated to cut off the other forearm. Next, skin with subcutaneous fat was removed from the carcass (excluding the forearms and the wingtips). In order to do that, the carcass was put on the table, breast side up. Skin was incised at the following points: a) along the breastbone crest, toward the neck, b) along the wings (from the end of the shoulder, along the body axis), and c) along the legs (from the shank joints to the opening made during carcass evisceration). Skin with subcutaneous fat was removed using a knife. The uropygial gland was left at the skin slice. In this way, a modified skin slice with subcutaneous fat (Figure 2a) was obtained based on the following fixed points of the skeleton: at the front - the line separating the head from the neck (between the occipital condyle and the atlas), legs - at the shank joints, wings - at the elbow joints. The above method can be applied to ducks (Bochno et al., 2007a) and geese (Bochno et al., 2007b). In broiler chickens, the entire rump, cut off between the third and

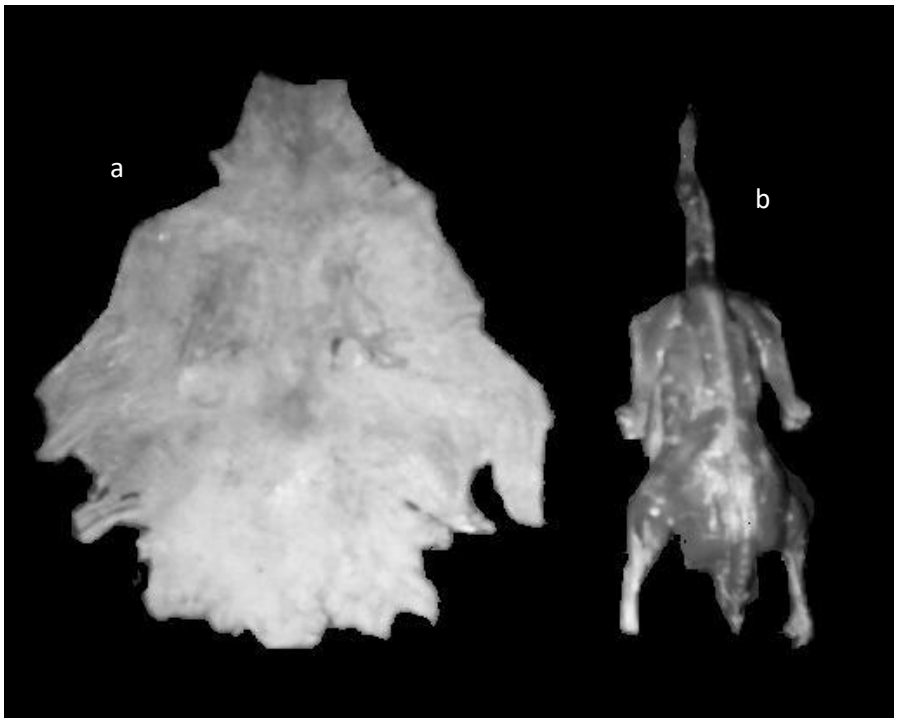


**Figure 2.** A modified skin slice with subcutaneous fat (a) and a carcass without this slice (b); duck carcass.

fourth coccygeal vertebra, was left at the skin slice (Bochno et al., 2004). In turkeys, part of the rump skin was excluded from the modified skin slice – the rump skin was removed along the cleavage in the hind part of the carcass (Figure 1b; Bochno et al., 2005). Shifting the cutting line from the imprecisely described region of the shoulder joint (Ziołecki and Doruchowski, 1989) to the elbow joint (connecting the humerus, the ulna and the radius (Figure 1a) ensures high reproducibility of results. In turkeys, leaving part of the rump skin at the carcass facilitates carcass dressing as the removal of skin inclusive of a subcutaneous fat layer poses difficulty in this fowl species.

**A modified skin slice with subcutaneous fat and carcass weight without this slice as indicators of total lean meat and fat content in poultry carcasses**

The weight of the modified skin slice with subcutaneous fat ($X_2$) was highly correlated with the total content of subcutaneous and intermuscular fat, including skin, in the carcass (U; $r > 0.99$, Table 1). It should be noted, however, that the very high coefficient of simple correlation between the above variables ($X_2$ and U) results primarily from autocorrelation, because skin slice weight accounts for approximately 79 and 87% of the total weight of skin with subcutaneous and intermuscular fat in the whole carcass in turkeys (Bochno et al., 2005) and in ducks (Bochno et al., 2007a), respectively. The other analyzed trait, carcass weight without the modified skin slice, forearms and wing tips ($X_1$), was strongly correlated with the total lean meat content of the carcass. This trait is a better indicator of carcass meatiness (r of approximately 0.99) than the commonly used breast muscle weight (r from 0.71 in ducks to 0.96 in broiler chickens) and leg muscle weight (r from 0.69 to 0.96, Table 1). Both analyzed traits, that is, the weight of the modified skin slice with subcutaneous fat ($X_2$) and carcass weight without this slice ($X_1$), which are highly correlated with the total content of lean meat and fat with skin in the carcass, are relatively easy to measure. Compared with carcass dissection and the determination of other traits, the proposed procedure of obtaining the modified skin slice is less labor- and time-consuming. Thus, both traits ($X_1$ and $X_2$) can be considered reliable and easy to apply indicators of carcass meatiness and fatness in four main fowl species.

**Regression equations**

The lean meat and fat content of poultry carcasses could be estimated based exclusively on the values of the investigated traits, the weight of the modified skin slice ($X_2$) and carcass weight without this slice ($X_1$). However, the tissue composition of the whole carcass is an important consideration in determining the slaughter

value of birds. The content of major carcass components – lean meat (Ŷ) and skin with subcutaneous and intermuscular fat (Û) - may be predicted with a relatively high accuracy using regression equations with traits $X_2$ and $X_1$ as independent variables. Similar results were reported when the content of lean meat and fat with skin in broilers (Bochno et al., 2004), ducks (Bochno et al., 2007a) and geese (Bochno et al., 2007b) was estimated using equations developed for both sexes and for males and females separately. This suggests that in the above species carcass meatiness and fatness can be calculated using equations based on data for both sexes. In turkeys, which show high sexual dimorphism, the content of lean meat and fat with skin in the carcass should be estimated using different equations for males and females (Bochno et al., 2005).

## Conclusions

The equations listed in Table 2 can be used at poultry breeding and testing stations. Lean meat content (Ŷ) in broiler chickens, ducks and geese can be estimated using Equations 1, 3 and 5, respectively, whereas the total weight of skin with subcutaneous and intermuscular fat (Û) can be calculated using Equations 2, 4 and 6. In turkeys, Equations 7 and 9 can be used for estimating lean meat weight in males and females, respectively, while fat and skin content can be calculated based on Equations 8 and 10. The proposed equations are reliable and easy to apply tools for predicting carcass meatiness and fatness in young slaughter birds. They may be used to determine the slaughter quality of poultry in experiments aimed at improving production technology, so as to increase carcass meatiness and reduce fatness.

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