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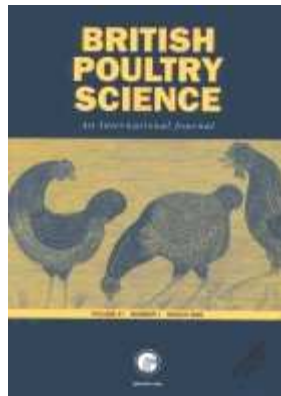
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**Use of a modified skin slice with subcutaneous fat and carcase weight without this slice
for prediction of meatiness and fatness in young slaughter geese**

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Short title : MODIFIED SKIN SLICE IN GEESE

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Abstract. 1. White Italian geese (40 males and 40 females) were reared until 12 weeks of age and fed standard diets *ad libitum*. After rearing ended, the geese were weighed (males - 5216 g, females - 4945 g) and killed. Carcasses were chilled and skin slices with subcutaneous fat removed. The remaining part of the carcass was dissected into meat, intermuscular fat and bones.

2. The weight of a skin slice with subcutaneous fat, taken from the carcass surface excluding the forewings and wing tips (X_2), and the weight of a carcass excluding this slice, the forewings and wing tips (X_1) were very good indicators of the content of skin with fat ($r > 0.99$) and meat ($r > 0.98$) in a whole carcass.

3. The above traits provided a basis for deriving regression equations to estimate the content of meat (\hat{Y}) or skin with subcutaneous and intermuscular fat (\hat{U}) in whole carcasses of White Italian geese. The following equations are recommended for practical application:

$$\hat{Y} = 0.755 X_1 - 27.8 \quad (S_y = 26.3 \text{ g}); \quad \hat{U} = 1.070 X_2 + 19.5 \quad (S_u = 11.4 \text{ g})$$

INTRODUCTION

Compared with other species of domestic fowls, geese and ducks have the greatest proportion of carcass fat. Efforts are being made to improve their welfare and husbandry conditions, because they have a significant effect on fatness. Birds in such experiments should be evaluated taking into account the meatiness and fatness of their carcasses. The most precise method for determining the proportions of carcass tissue components is detailed dissection, but this procedure is time-consuming and expensive. The chemical composition of a carcass is even more difficult to determine (Leeson and Summers, 1980; Walters *et al.*, 1994). Therefore, there is a need for simple indirect methods for predicting the content of lean and fat in carcasses of experimental birds.

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1 Numerous studies have been conducted to determine the suitability of various traits,
2 measured *in vivo* or postmortem, for predicting carcass meatiness and fatness. Breast muscle
3 thickness (Pingel and Heimpold, 1983) and breast-bone crest length (Canope *et al.*, 1997)
4 measured *in vivo*, as well as breast muscle weight, thigh muscle weight and drumstick muscle
5 weight measured postmortem, are good indicators of carcass meatiness in poultry. Carcass
6 fatness is usually estimated postmortem on the basis of abdominal fat weight. However, there
7 seem to be no reliable *in vivo* indices of carcass fatness.

8 Small fragments of skin with fat were found to be weakly correlated with the fat
9 content of a whole carcass (Walters *et al.*, 1994). A high correlation was observed between a
10 slice of skin with subcutaneous fat, taken from the surface of a carcass excluding the wings
11 (Ziołocki and Doruchowski, 1989), and carcass fatness in geese ($r > 0.98$; Bochno *et al.*, 1995)
12 and other domestic fowl species. However, the method of obtaining this skin slice showed
13 methodological imprecision, namely an imprecise determination of the line separating the
14 skin that covers the wings, from the skin that covers the remaining part of the carcass. Thus
15 results obtained by particular authors using this method could differ. To eliminate the above
16 imprecision, we decided to modify this method. Experiments performed on broiler chickens,
17 turkeys and ducks yielded satisfactory results (Bochno *et al.*, 2003, 2004, 2005). The new
18 method, based on fixed points of the skeleton, ensures high reproducibility of results.

19 The aims of the present study were: 1. to modify the method for obtaining a skin slice
20 with subcutaneous fat, and to verify the suitability of this skin slice for fatness prediction in
21 whole carcasses of White Italian geese, 2. to verify the suitability of carcass weight without a
22 modified skin slice, forewings and wing tips for meatiness prediction in whole carcasses of
23 White Italian geese, 3. to derive regression equations for estimating the content of meat and
24 fat with skin in whole carcasses of young geese, with the weight of a modified skin slice and
25 the weight of a carcass without this slice as independent variables.

MATERIALS AND METHODS

The experiment was performed on White Italian geese (40 males and 40 females). The birds were reared to 12 weeks of age and fed standard diets *ad libitum*: R-225 (starter, to 5 weeks of age) and R-226 (grower/finisher, from 6 to 12 weeks), containing 20.16% and 19.14% of total protein and 12.34 MJ and 12.10 MJ of ME respectively. After the completion of the rearing period the birds were fasted for about 12 h, and then killed, plucked and eviscerated at a poultry slaughterhouse, in accordance with the relevant technological standards (electronarcosis before slaughter).

The main objective of the study was to modify the method for obtaining a skin slice with subcutaneous fat, developed by Ziotecki and Doruchowski (1989). Following an analysis and preliminary tests, a fragment of skin covering the wings was included into a modified skin slice. The imprecisely determined line of cutting was shifted from the region of the shoulder joints to a more precise point at the elbow joint (connecting the humerus with the radius and ulna bones).

Procedure

A chilled carcass (refrigerated at 4°C for about 24 h) was placed on the table, back upward. One of the wings was tightened a little and the forewing with the wing tip was separated from the carcass with a knife, so as to divide the angle between the humerus and the radius/ulna into two equal parts (Figure 1). The other wing was cut off in a similar way. Then skin with subcutaneous fat was taken off from the carcass (without the forewings and wing tips). In order to do that, the carcass was put on the table, breast upward. At first the skin was incised: 1) along the breast-bone crest, towards the neck, 2) along the wings (from the end of the wing, along the body axis), 3) along the legs (from the shank joints to the hole made during carcass evisceration). Then skin was taken off together with subcutaneous fat, with a knife. The

1 uropygial gland was left at the skin slice. In this way a modified skin slice with subcutaneous
2 fat was obtained on the basis of fixed points of the skeleton : at the front – a line separating
3 the head from the neck (between the occipital condyle and the atlas); legs – at the shank
4 joints, wings – at the elbow joints. It took about 20 min to remove the skin slice from the
5 carcass, compared with about 6 man-hours needed for detailed carcass dissection.

6 A carcass without the skin slice, forewings and wing tips (Figure 2b) was weighed and
7 divided into parts (legs, wings, breast and back), which were dissected into meat,
8 intermuscular fat and bones. The wings were also dissected into the above components and
9 skin with subcutaneous fat. Meat weight and bone weight in a whole carcass were
10 determined as sums of these components from particular carcass elements (neck, wings, legs,
11 back and breast), and the weight of skin with fat – as a sum of the weight of a skin slice with
12 fat, skin with subcutaneous fat from the wings and intermuscular fat from all carcass
13 elements.

14 The statistical analysis (Statistica, STATSOFT INC., 2001) included calculation of
15 arithmetic means (\bar{x}) and coefficients of variation (v), determination of the significance of
16 differences between males and females (Fisher test), calculation of the coefficients of simple
17 correlation between the weight of meat or fat with skin in a whole carcass, and the other traits
18 (r), and the derivation of regression equations for predicting the content of meat and skin with
19 fat (subcutaneous + intermuscular) in a whole carcass.

20 RESULTS

21 **Detailed statistical description of data**

22 Mean live body weights of males and females were 5216 g and 4945 g respectively, while
23 whole carcass weights were 3241 g and 3068 g. There were significant differences between

the sexes in total meat weight in a whole carcass, and in the weight of a carcass from which the modified slice of skin with fat had been removed (Table1).

Among the traits analysed, the strongest correlation was found between the meat content of a whole carcass and carcass weight minus the weight of skin slice with subcutaneous fat, wing weight and wing tip weight (X_1). A considerably weaker correlation was found between the meat content of a whole carcass and whole carcass weight, breast muscle weight, leg muscle weight (thigh + drumstick) and body weight. The content of fat with skin in a carcass was very strongly correlated with the weight of a modified skin slice with subcutaneous fat, and to a much lesser extent with abdominal fat weight, body weight and carcass weight.

Regression equations

The traits that showed the highest correlation with carcass meatiness or fatness served as independent variables in regression equations. In regression equations for predicting the content of fat with skin in a whole carcass (\hat{U} ; g) the independent variable was the weight of a modified skin slice with subcutaneous fat (X_2), and in regression equations for meat content estimation – carcass weight without this slice, forewings and wing tips (X_1). First the equations were formulated based on data for males and females separately. Then the equations based on data for males (equations 1 and 4, Table 2) were compared with corresponding equations based on data for females (equations 2 and 5). The lack of significant differences in the values of regression coefficients enabled additional equations based on data for both males and females to be calculated (equations 3 and 6; Snedecor and Cochran, 1976). All equations are characterised by very small standard errors of the estimate ($S_y \leq 29.1$, $S_u \leq 12.5$ g).

DISCUSSION

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The main objective of this study was to modify and improve the method for obtaining a skin slice with subcutaneous fat. We moved the previously imprecisely-determined line of cutting from the region of the shoulder joint (Ziołlecki and Doruchowski; 1989) to the elbow joint (connecting the humerus with the radius and ulna bones – Figure 1a). Some changes were also introduced to make the method suitable for particular species of poultry. In chickens a modified slice of skin with subcutaneous fat included the rump, and was cut off the carcass between the third and fourth caudal vertebra (Bochno *et al.*, 2003). In turkeys a modified skin slice did not include skin with subcutaneous fat from the rump, because it is very difficult to separate these carcass components (Bochno *et al.*, 2005). In ducks (Bochno *et al.*, 2004) and geese (cf. Materials and Methods) a slice of skin with fat includes skin with subcutaneous fat from the rump and the uropygial gland.

The weight of a modified skin slice (X_2) is a very good indicator of the content of skin with subcutaneous and intermuscular fat in a whole carcass (U ; $r > 0.99$). It should be noted, however, that the very high simple correlation between variables X_2 and U results primarily from autocorrelation, because skin slice weight constitutes over 91% of the total weight of skin with subcutaneous and intermuscular fat in a whole carcass (Table 1). The other trait, i.e. the weight of a carcass excluding the modified skin slice, forewings and wing tips (X_1), is a very good indicator of carcass meatiness (r approx. 0.98).

For the purpose of comparative analysis, the prediction of carcass meatiness and fatness may be based on indices X_1 and X_2 only. However, data concerning the tissue composition of a whole carcass are more reliable as regards slaughter quality determination. The content of major carcass components (meat (\hat{Y}) and skin with subcutaneous and intermuscular fat (\hat{U})) may be predicted with relatively high accuracy using the regression equations presented in the paper, having these two traits as independent variables. This is confirmed by relatively small standard errors of the estimate of these equations. In order to

1 simplify the procedure of evaluating carcass meatiness and fatness in males and females, we
2 recommend the use of equations calculated for both sexes.

3 In conclusion, the two new traits determined in the study, namely the weight of a
4 modified skin slice with subcutaneous fat (X_2) and carcass weight excluding this slice,
5 forewings and wing tips (X_7), are very good indicators of carcass fat and meat content,
6 respectively. The regression equations with these traits as independent variables are
7 recommended for predicting the content of meat (equation 3) and fat with skin (equation 6) in
8 whole carcasses of young slaughter geese. They are especially useful for determining the
9 slaughter quality of geese in experiments aimed at improving production technology, directed
10 towards high meatiness and low fatness.

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Table 1. Arithmetic means (\bar{x}), coefficients of variability (v) and coefficients of simple correlation (r) between the content of meat (Y) or skin with subcutaneous and intermuscular fat (U) in the carcass and the traits examined ($n=40\text{♂}$ and 40♀)

Specification	Symbols	Sex	Characteristics		r	
			\bar{x}	v	Y	U
Body weight before slaughter (g)		♂♀	5082.5	9.34	0.848	0.760
		♂	5215.6*	9.06	0.857	0.822
		♀	4945.5	8.95	0.816	0.798

Weight (g) of:

Whole cold carcase		♂♀	3155.7	10.77	0.891	0.790
		♂	3240.6**	10.23	0.899	0.851
		♀	3068.2	10.76	0.877	0.812
Carcase without the skin slice, forewings and wing tips	X_1	♂♀	2062.8	9.93	0.986	0.457
		♂	2144.8**	8.47	0.978	0.553
		♀	1978.4	9.86	0.991	0.499
Weight of modified skin slice (g)	X_2	♂♀	787.67	20.29	0.420	0.998
		♂	778.49	21.04	0.540	0.998
		♀	797.12	19.77	0.417	0.997
Weight of breast muscles (g; left side of carcase)		♂♀	242.07	13.58	0.890	0.516
		♂	248.80	11.96	0.881	0.567
		♀	235.13	14.85	0.906	0.519
Weight of leg muscles (g; thigh + drumstick; left)		♂♀	253.12	10.49	0.864	0.364
		♂	258.12	9.61	0.853	0.476
		♀	247.97	11.15	0.883	0.306
Weight of abdominal fat (g)		♂♀	145.58	40.25	0.291	0.881
		♂	141.23	41.22	0.367	0.862
		♀	150.07	39.68	0.324	0.901
Content in the carcase (g) of:						
Meat	Y	♂♀	1529.1	10.25		0.453
		♂	1585.5**	8.75		0.564
		♀	1471.1	10.53		0.459
Skin with subcutaneous and intermuscular fat	U	♂♀	862.01	19.87	0.453	
		♂	853.07	20.53	0.564	
		♀	871.22	19.46	0.459	

Means (for both sexes) marked with ** or * differ at $\alpha = 0.01$ and 0.05 , respectively

Critical values of r $\alpha = 0.01 - 0.393$; r $\alpha = 0.05 - 0.304$;

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Table 2. *Regression equations for estimation the content of meat (\hat{Y} , g) and skin with subcutaneous and intermuscular fat (\hat{U} , g) in the carcase and standard errors of estimation ($S_{y/u}$)*

No.	Regression equation *	$S_{y/u}$
1	$\hat{Y}_{\sigma} = 0.748X_1 - 17.79$	29.1
2	$\hat{Y}_{\varphi} = 0.787X_1 - 85.51$	21.8
3	$\hat{Y}_{\sigma\varphi} = 0.755X_1 - 27.85$	26.3
4	$\hat{U}_{\sigma} = 1.068X_2 + 21.98$	10.6
5	$\hat{U}_{\varphi} = 1.073X_2 + 16.21$	12.5
6	$\hat{U}_{\sigma\varphi} = 1.070X_2 + 19.50$	11.4

X_1, X_2 — see Table 1



Figure 1. *Line of cutting off the forearm and tip from the arm*

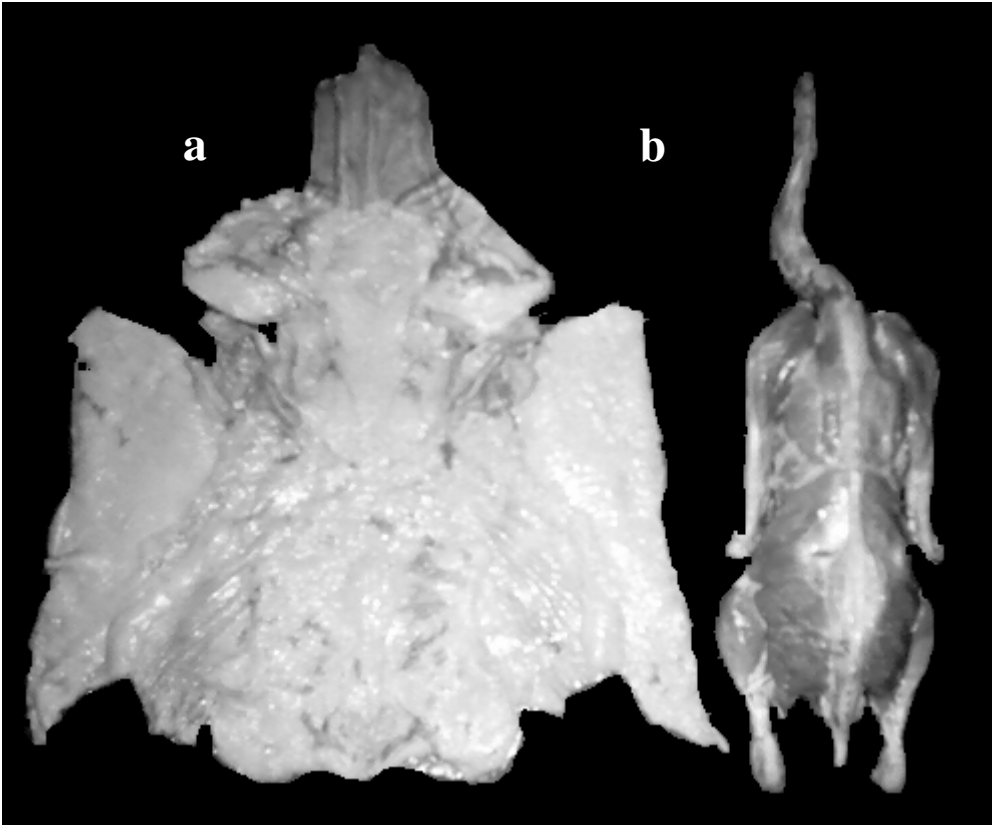


Figure 2. *Modified skin slice with subcutaneous fat (a) and a carcass without this slice (b)*



Figure 1. *Line of cutting off the forearm and tip from the arm*

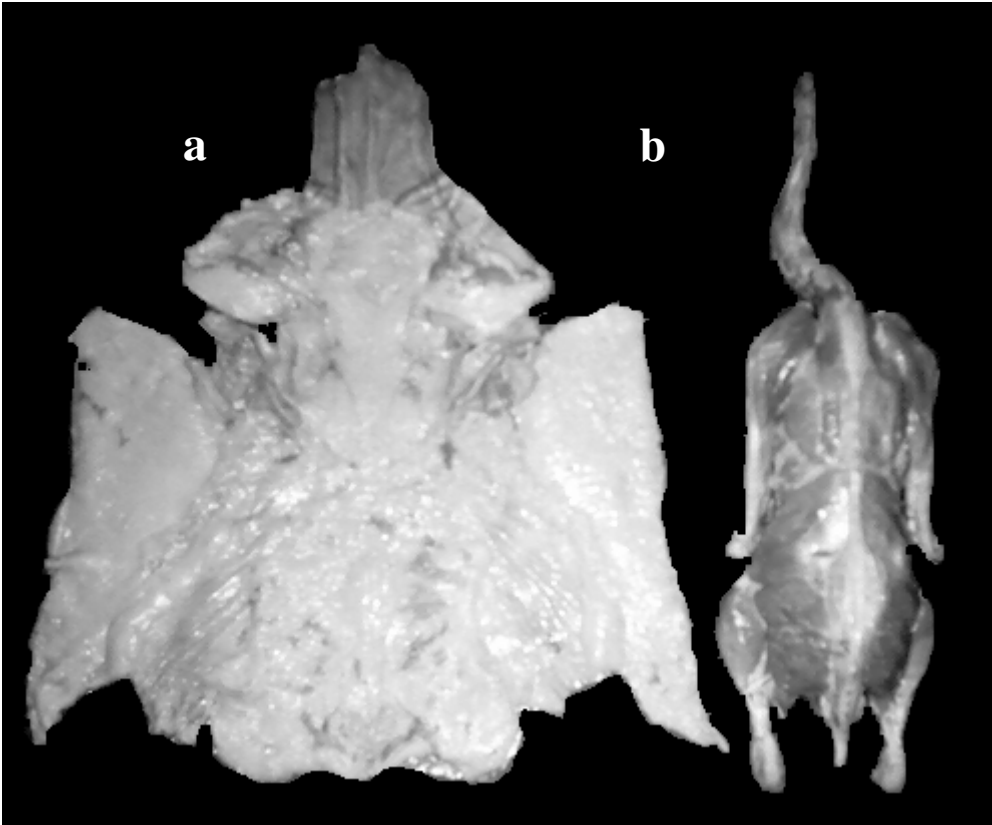


Figure 2. *Modified skin slice with subcutaneous fat (a) and a carcass without this slice (b)*

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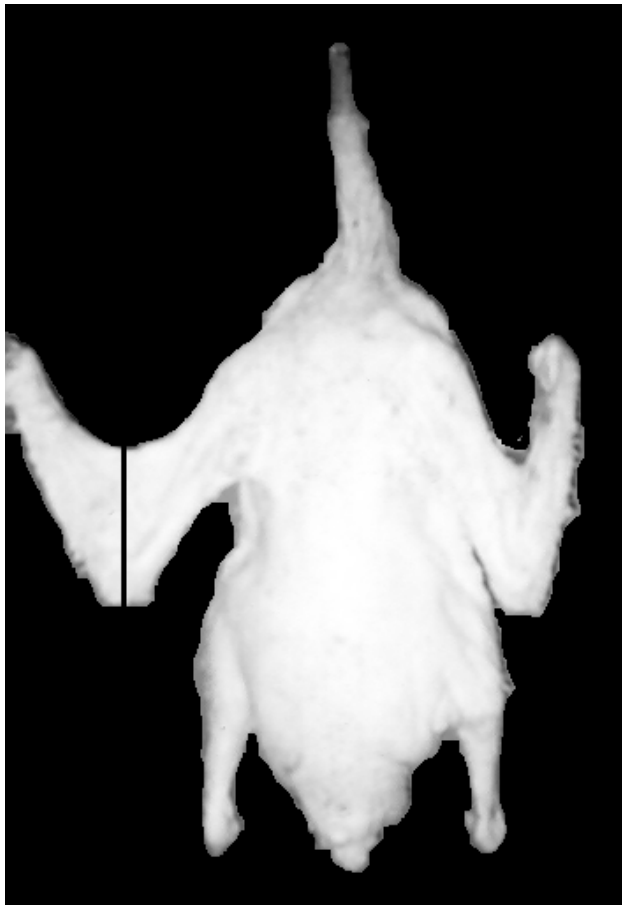


Figure 1. *Line of cutting off the forewing and wingtip from the wing*

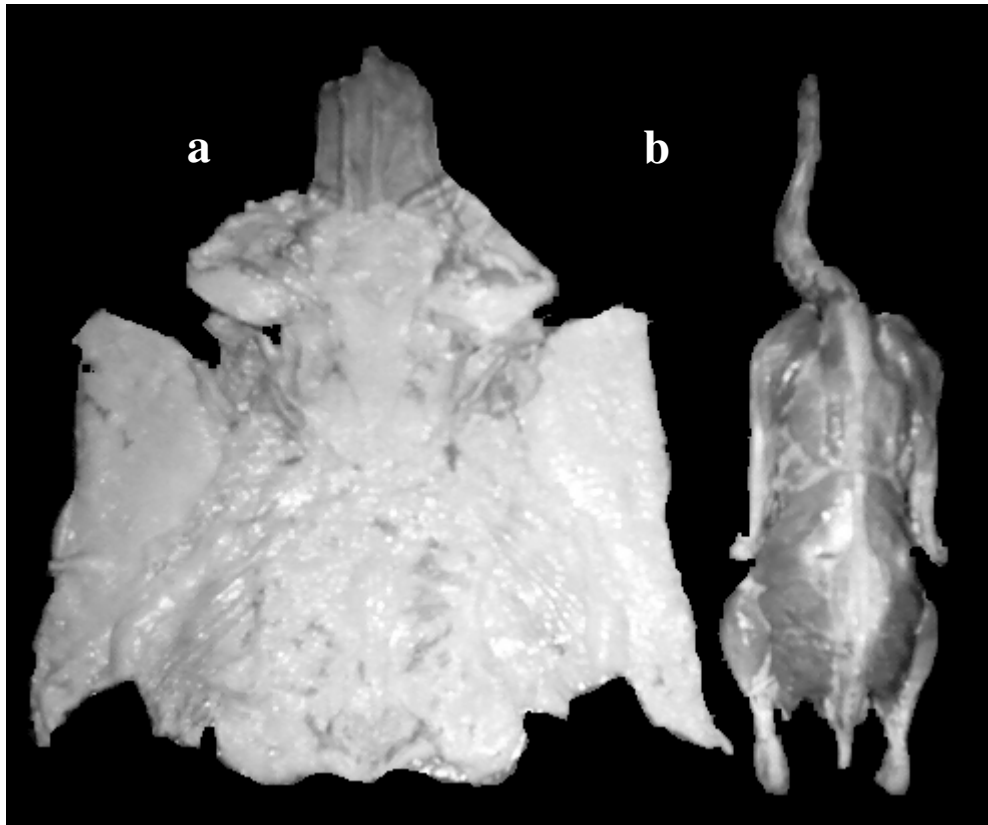


Figure 2. *Modified skin slice with subcutaneous fat (a) and a carcass without this slice (b)*