# ANALYSIS OF THE BELLY MEAT PART FORMATION IN RELATION TO CARCASS WEIGHT IN PIGS*

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The trials were performed in 194 final hybrid pigs of well-balanced sex, commonly used breeding combinations in the Czech Republic. The objective was to examine the belly meat part formation with respect to its total content as well as its formation in the carcass and lean meat share depending on achieved carcass weight. It was demonstrated that increasing weight within the monitored group of pigs does not result in higher belly share in the carcass, whereas the percentage growth of EU-belly as well as total belly part was consistent. The increasing carcass weight results with dramatically lower rising of absolute amount of lean meat in the belly (2.05 kg/95 kg vs. 2.33 kg/115 kg) whereas belly lean meat share decreased (55.68%/95 kg vs. 52%/115 kg). Lean meat share and belly one do not achieve the same values. The higher carcass, the higher difference between them. The increasing pigs' weight results in statistically significant rising of total belly meat area (9274 $mm^2$/95 kg vs. 10 869 $mm^2$/115 kg), but only in slight statistically insignificant rising of lean meat area (5766 $mm^2$/95 kg vs. 6291 $mm^2$/115 kg). The increasing of total belly area from the cut 1 to 3 is confirmed. Identical tendency was registered in all weight categories, increasing body weight results in increasing belly area and simultaneously in slower rising of meat area. There is a decreasing tendency of lean meat share especially in maximum live weight of 105 kg, subsequently there is no significant decrease of lean meat share; the belly meat part maintains the same content of lean meat also fat within the monitored weight. Different lean meat and fat deposition in individual cuts in animals with different carcass weight was confirmed.

pig; belly; weight

## INTRODUCTION

Development of genetic potential in carcass value, especially in lean meat share, demands consequent monitoring and evaluation of all factors including slaughter weight, which dramatically affects slaughter realization in pigs.

The age of pigs is closely connected with live weight. Lean meat and fat part contents are changed with increasing slaughter weight in pigs. Together with this the carcass value is changed (Hovorka, 1989; Cisneros et al., 1996). Willam et al. (1990) pointed out that slaughter weight is the most important factor affecting the carcass value. Hruška (1997) refers to the fact that slaughter weight in pigs affects lean meat share in the carcass and subsequently the pig SEUROP classification. Podębradský (1994) confirms in his work that lean meat share is higher by 2–3 % with decreasing slaughter weight from 115 kg to 110 kg live weight.

For achievement of higher lean meat share in the carcass and better realization it is efficient to focus on increasing lean meat share in individual carcass parts. From point of view as a very interesting part appear belly and its meat/fat content. Lonergan et al. (2001) found out that selection for high increase of lean meat content in pigs is connected with better meat formation and its content in belly, higher MLLT area as well as decreased fat formation.

In comparison with other important carcass body parts, the proportion of lean meat and fat in belly could be considerably different (Pfeiffer et al., 1993; Schreinemachers et al., 1999; Tholen et al., 2003; Stupka et al., 2004; Vališ et al., 2001, 2005).

Pulkrábek et al. (2001) indicate that lean meat share in belly dramatically varies between one and two thirds. Authors pointed out that in the spot light of today's consumer requests this part could be advantageously used only when lean meat share approaches to upper limit of the mentioned range.

Kyselica et al. (2001) found that belly in which lean meat share exceeds 65%, participates in lean meat share in carcass body of meat types in pigs.

Pulkrábek et al. (1998), Čítek (2002), Čechová, Mikule (2004) and Šprysl et al. (2005) were interested in pig production potential fed into different weight before their slaughter.

Kopecký et al. (1972), Poltársky, Palanská (1991) and Šprysl et al. (2000) pointed out on decreasing levels of traits characterizing lean meat share and increasing trait levels characterizing fat share in the carcass with increasing age in pigs.

Vališ et al. (2001) found out lean meat share in the belly set out by dissection with slaughter weight 100 kg in gilts/barrows at the level of 58.83 ± 1.102% / 55.21 ± 1.514%. According to Willam et al. (1990) fat share in the belly increases more than in other carcass parts with increasing slaughter weight.

Gráčik et al. (1986) found out that percentage of individual carcass parts decrease with increasing live

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weight. The belly share represents in 100 kg 16.28 kg = 21.14%, 110 kg 17,92 kg = 21.25%, 120 kg 19.89 kg = 21.40%, 130 kg 21.44 kg = 21.83%, 140 kg 23.36 kg = 22.02% and in 150 kg 26.42 kg = 23.13%.

## MATERIAL AND METHODS

The objective of this trial was to verifiy the efect of various carcass weight on quantitative and qualitative carcass belly part composition in recommended final hybrid pigs used in the Czech Republic. The study verifies the hypothesis that increased body weight changes markedly a belly part formation from point of view of meat-fat content.

The analysis of the belly meat part included in total 194 slaughter pigs of various genotype where Czech Large White and Landrace breeds were used in dam position while the breeds of Pietrain x Duroc, Pietrain x Large White (sire line), Pietrain x Hampshire and Pietrain were in the sire position.

The experiment took place in the testing station of the branch of the Department of Animal Science of the Faculty of Agrobiology, Food and Natural Resources of the Czech University of Life Sciences in Prague.

The pigs of balanced sex were slaughtered at the age of 166–175 days. In order to perform an objective analysis of carcass body weight influence on meat part belly formation, the monitored group was divided into 6 subgroups according to achieved live weight, namely less than 95 kg, 95–100 kg, 100–105 kg, 105–110 kg, 110–115 kg and more than 115 kg.

In terms of monitoring the partial indicators characterized belly part formation the lean meat share of pig carcasses (%) was also monitored by help of Fat-O-Meater-formula (P u l k r á b e k et al., 2004).

The slaughter pigs included in the test were fed according to the standards of the need of nutrients after Š i m e č e k et al. (2000) ad-libitum in three phases with a continuous transition by means of self-feeders Duräumat.

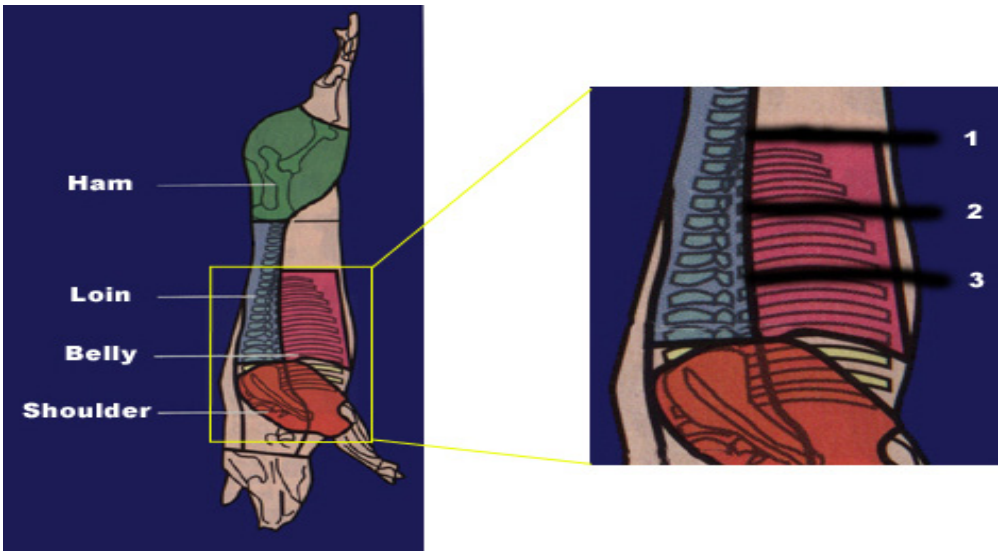
Table 1. Feeding scheme

| Nutrients in FCM | Feeding phase | | |
|---|---|---|---|
| | up to 35 kg | 35–65 kg | over 65 kg |
| Crude protein (g/kg) | 196.70 | 184.00 | 156.30 |
| ME (MJ/kg) | 13.30 | 13.20 | 12.90 |
| Crude fiber (g/kg) | 39.84 | 38.76 | 40.75 |
| Lysine (g/kg) | 11.40 | 10.20 | 8.30 |
| Threonine (g/kg) | 7.20 | 6.50 | 5.40 |
| Methionine (g/kg) | 3.20 | 2.90 | 2.40 |
| Ca (g/kg) | 7.20 | 6.80 | 6.10 |
| P (g/kg) | 5.50 | 5.40 | 4.60 |

Feeding complex mixtures (FCM) used in the tests were four-component mixtures using wheat, barley, soya-meal and a feeding supplement. Prior to the beginning of tests analyses were made of individual components used in the feeding mixtures in terms of the content of nutrients and based on the identified values feeding mixtures were composed in relation to age and live weight of the tested pigs. The feeding mixtures were mixed for each pen separately according to the designed scheme of the test (Table 1).

The pigs were penned according to the methodology for testing thoroughbred and hybrid pigs observing the principle of penning of animals in couples.

The belly dissection was made according to the EU methodology, separating the frontal part of the one between 4th and 5th rib, the anterior part of the belly was separated by a section made 4 cm caudally behind the last rib first vertically and subsequently cranially close to the row of mammary glands ducts.




In order to evaluate the belly formation with the subsequent determination of the estimate of the share of lean meat in the carcass belly, radiographs were made of the section of the carcass part of the EU belly at three points according to the methodology of S c h w e r d t f e g e r et

al. (1993), namely section 1 behind the last rib, section 2 between 10th and 11th rib and section 3 between 7th and 8th rib. The LUCIA programme of the company Laboratory Imaging Ltd. was used to measure in sections 1, 2 and 3 the area of the belly ($mm^2$), the area of the meat ($mm^2$) and the ratio of lean meat in the section area of the belly to the total area of the belly (%).

Lean meat and its share in the belly were calculated by means of the equation after Čítek (2002):

$$y = 42.63841413 + 0.24603687 * PLPODIL2 - 3.43803239 * HMEU - 0.00098125 * PLCELK3 + 0.00254507 * PLMASO3 + 0.00088281 * PLMASO1 \quad (r^2 = 0.857),$$

where:

PLPODIL2 – the ratio of the area of lean meat to the total area of the belly at the point of section 2 (%)
HMEU – weight of the part of the belly dissected according to EU (kg)
PLCELK3 – total area of the belly at the point of section 3 ($mm^2$)
PLMASO1 – the area of lean meat at the point of section 1 ($mm^2$)
PLMASO3 – the area of lean meat at the point of section 3 ($mm^2$)

The dataset was analysed by ANOVA through the statistical program SAS 9.1.3. – GLM. The following linear regression model was used to estimate the effects of body weight:

$$Y_i = \mu + CW_i + e_i,$$

where: $Y_i$ – observed value of the carcass parameter as a dependent variable
$\mu$ – average value of dependent variable
$CW_i$ – fixed effect of liveweight
$e_i$ – residual effects (random error)

## RESULTS AND DISCUSSION

The monitored group of pigs was divided into 6 subgroups with 5 kg live weight difference.

The performed evaluation of belly meat part content in the carcass shows Table 2.

Within examination of belly carcass part as a whole was logically found out that there was statistically significant increasing of belly meat part with increasing live weight in pigs.

Providing that group with live weight up to 95 kg presents 100% of carcass belly part, it could be stated that in other groups the carcass belly part represents 108.3, 112.8, 114.8, 118.2 and 123.7%. The differences were 8.3, 12.8, 14.8, 18 and 23.7%. On the other hand there were found out no significant differences among monitored groups as regards percentage of belly in the carcass. It could be mentioned that there is no higher belly share in the carcass with increasing weight within monitored group of pigs. The same tendency was obtained in EU-belly part from carcass as well as in percentage of EU-belly part from total belly and from carcass.

By detailed survey of achieved weight of EU-belly from carcass it could be said that supposing EU-belly weight in pigs up to 95kg live weight is 100 %, other groups will achieve the following levels: 106.5, 113.3, 114.6, 119.3 and 122%. Then differences are 6.5, 13.3, 14.6 19.3 and 22%. Comparing these differences with values found out in total belly part, it is evident that there is the same percentage rising in both monitored indicators. Trend of rising with increasing weight of pigs is kept in belly lean meat share. Statistically significant differences were obtained especially between the lightest and the heaviest group. If lean meat in belly in group with live weight up to 95 kg will be considered as 100%, then values in other groups increase on 105.3, 109.8, 108.7, 112.2 and 113.7%. It is evident that the belly lean meat share rises much lower with increasing weight of pigs.

As regards the lean meat percentage in belly, decreasing belly lean meat share with increasing weight of pigs could be monitored. It could be said that belly share in relation to carcass is not markedly changed with increasing weight, but belly lean meat share is decreasing (Fig. 1). It is caused by higher fat deposition in comparison with meat in pigs with higher weight.

The same tendency is findable for lean meat percentage in the carcass. It is obvious that carcass lean meat

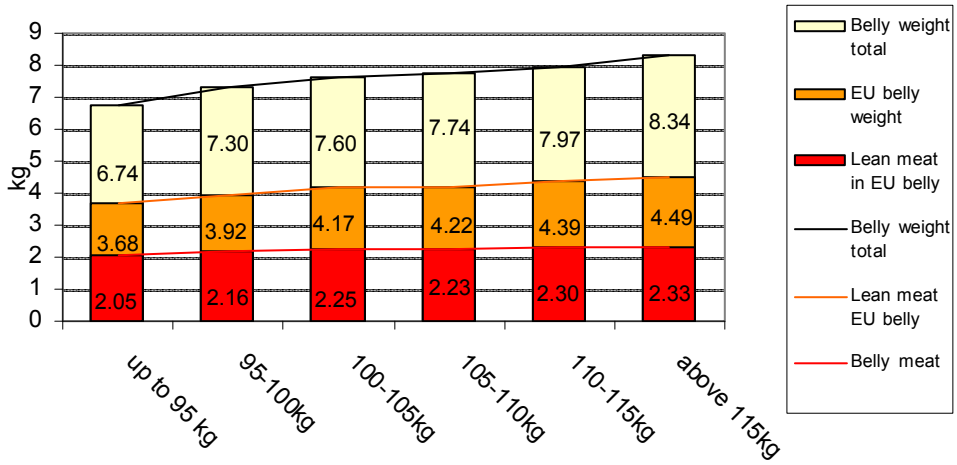



Fig. 1. Belly characteristics with respect to achieved live weight

Table 2. Estimation of the belly-meat part with respect to lean meat share in pig carcasses

| Indicator | Less 95 kg ($n$ = 9) | | 95–100 kg ($n$ = 13) | | 100–105 kg ($n$ = 44) | | 105–110 kg ($n$ = 59) | | 110–115 kg ($n$ = 46) | | Over 115kg ($n$ = 22) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | mean | SD | mean | SD | mean | SD | mean | SD | mean | SD | mean | SD | $F$-value | $F$-test |
| Belly weight total (kg) | $6.74^{E}$ | 0.10 | $7.30^{D}$ | 0.16 | $7.60^{CD}$ | 0.08 | $7.74^{CB}$ | 0.06 | $7.97^{B}$ | 0.09 | $8.34^{A}$ | 0.14 | 16.14 | 0.0001 |
| Total belly share in the right half (%) | 17.67 | 0.32 | 18.23 | 0.37 | 18.14 | 0.15 | 17.76 | 0.12 | 17.69 | 0.17 | 17.85 | 0.30 | 1.24 | 0.2913 |
| EU belly weight (kg) | $3.68^{D}$ | 0.10 | $3.92^{C}$ | 0.14 | $4.17^{B}$ | 0.05 | $4.22^{B}$ | 0.05 | $4.39^{AB}$ | 0.05 | $4.49^{A}$ | 0.09 | 9.63 | 0.0001 |
| EU belly share in the right half (%) | 9.66 | 0.31 | 9.78 | 0.32 | 9.96 | 0.12 | 9.68 | 0.10 | 9.75 | 0.12 | 9.61 | 0.18 | 0.78 | 0.5675 |
| EU belly share in the total belly (%) | 54.63 | 1.37 | 53.58 | 1.23 | 54.90 | 0.44 | 54.48 | 0.41 | 55.09 | 0.43 | 53.93 | 0.80 | 0.74 | 0.5947 |
| Lean meat in EU belly (kg) | $2.05^{C}$ | 0.05 | $2.16^{BC}$ | 0.08 | $2.25^{AB}$ | 0.03 | $2.23^{AB}$ | 0.03 | $2.30^{AB}$ | 0.03 | $2.33^{A}$ | 0.04 | 3.09 | 0.0105 |
| Lean meat share in EU belly (%) | $55.68^{A}$ | 1.12 | $55.27^{AB}$ | 0.94 | $54.00^{ABC}$ | 0.62 | $53.04^{ABC}$ | 0.51 | $52.56^{BC}$ | 0.66 | $52.00^{C}$ | 0.91 | 2.26 | 0.0505 |
| Lean meat share in pig carcasses (%) | 57.03 | 1.19 | 57.30 | 0.91 | 55.74 | 0.54 | 56.72 | 0.58 | 55.31 | 0.57 | 55.02 | 0.92 | 1.35 | 0.2472 |

$^{A, B, C, D}$ Means within the row of groups within different letters are significantly different ($P < 0.05$)

Table 3. Estimation of the belly-meat part with respect to lean meat share in pig carcasses

| Indicator | Less 95 kg ($n$ = 9) | | 95–100 kg ($n$ = 13) | | 100–105 kg ($n$ = 44) | | 105–110 kg ($n$ = 59) | | 110–115 kg ($n$ = 46) | | Over 115kg ($n$ = 22) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | mean | SD | mean | SD | mean | SD | mean | SD | mean | SD | mean | SD | $F$-value | $F$-test |
| Total area of belly on section 1 ($mm^2$) | $7\,477^{B}$ | 174 | $7\,575^{B}$ | 247 | $8\,608^{A}$ | 174 | $8\,632^{A}$ | 133 | $9\,048^{A}$ | 164 | $9\,005^{A}$ | 242 | 6.61 | 0.0001 |
| Total area of belly on section 2 ($mm^2$) | $9\,641^{B}$ | 453 | $9\,735^{B}$ | 431 | $10\,915^{A}$ | 210 | $10\,647^{A}$ | 168 | $11\,335^{A}$ | 216 | $11\,253^{A}$ | 360 | 4.56 | 0.0006 |
| Total area of belly on section 3 ($mm^2$) | $10\,703^{C}$ | 361 | $10\,808^{BC}$ | 415 | $11\,900^{A}$ | 207 | $11\,659^{AB}$ | 196 | $12\,369^{A}$ | 207 | $12\,348^{A}$ | 350 | 4.38 | 0.0009 |
| Total belly area (points 1–3 average) ($mm^2$) | $9\,274^{B}$ | 281 | $9\,373^{B}$ | 327 | $10\,474^{A}$ | 158 | $10\,313^{A}$ | 138 | $10\,917^{A}$ | 173 | $10\,869^{A}$ | 294 | 6.72 | 0.0001 |
| Lean meat area on section 1 ($mm^2$) | 4 778 | 139 | 4 937 | 171 | 5 249 | 118 | 5 063 | 83 | 5 175 | 132 | 5 297 | 180 | 1.11 | 0.3560 |
| Lean meat area on section 2 ($mm^2$) | 5 958 | 243 | 5 983 | 344 | 6 572 | 149 | 6 228 | 162 | 6 677 | 151 | 6 535 | 225 | 1.82 | 0.1118 |
| Lean meat area on section 3 ($mm^2$) | 6 562 | 270 | 6 789 | 303 | 7 021 | 148 | 6 868 | 139 | 7 085 | 160 | 7 041 | 201 | 0.63 | 0.6790 |
| Lean meat area (points 1–3 average) ($mm^2$) | 5 766 | 207 | 5 903 | 239 | 6 281 | 115 | 6 053 | 111 | 6 312 | 131 | 6 291 | 181 | 1.44 | 0.2116 |
| Share of meat area in the total area on section 1 (%) | $64.28^{A}$ | 2.79 | $65.49^{A}$ | 1.84 | $61.35^{AB}$ | 1.13 | $58.86^{B}$ | 0.74 | $57.20^{B}$ | 1.03 | $58.81^{B}$ | 1.20 | 4.95 | 0.0003 |
| Share of meat area in the total area on section 2 (%) | 62.14 | 2.00 | 61.23 | 1.82 | 60.46 | 1.11 | 58.49 | 1.15 | 59.06 | 1.02 | 58.28 | 1.34 | 0.85 | 0.5176 |
| Share of meat area in the total area on section 3 (%) | $61.37^{AB}$ | 1.86 | $63.00^{A}$ | 1.98 | $59.12^{AB}$ | 0.95 | $58.95^{AB}$ | 0.75 | $57.42^{B}$ | 1.08 | $57.35^{B}$ | 1.41 | 2.04 | 0.0753 |
| Share of meat area in the total area (points 1–3 average) (%) | $62.27^{AB}$ | 1.81 | $63.06^{A}$ | 1.60 | $60.13^{ABC}$ | 0.92 | $58.70^{BC}$ | 0.74 | $57.91^{C}$ | 0.93 | $58.06^{C}$ | 1.21 | 2.49 | 0.0328 |

$^{A, B, C, D}$ Means within the row of groups within different letters are significantly different ($P < 0.05$)

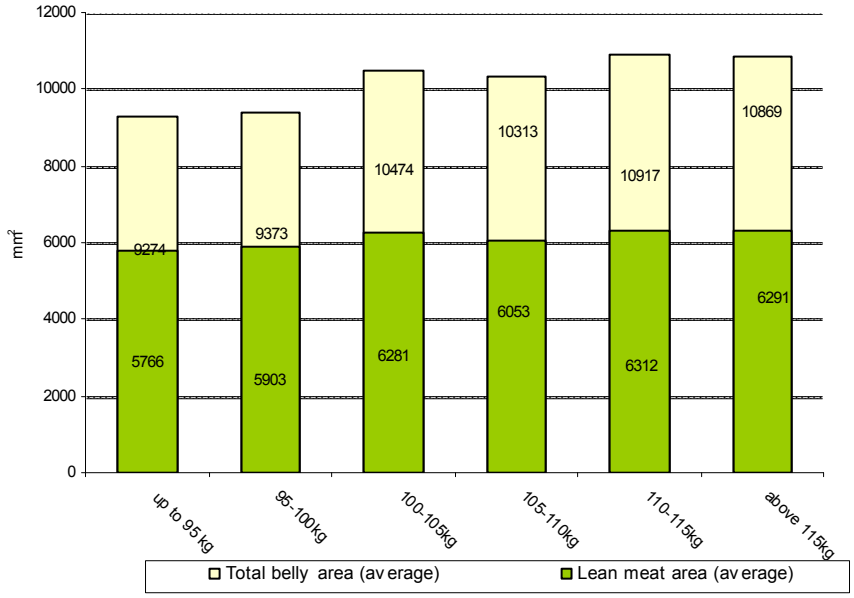



Fig. 2. Belly characteristics with respect to achieved live weight

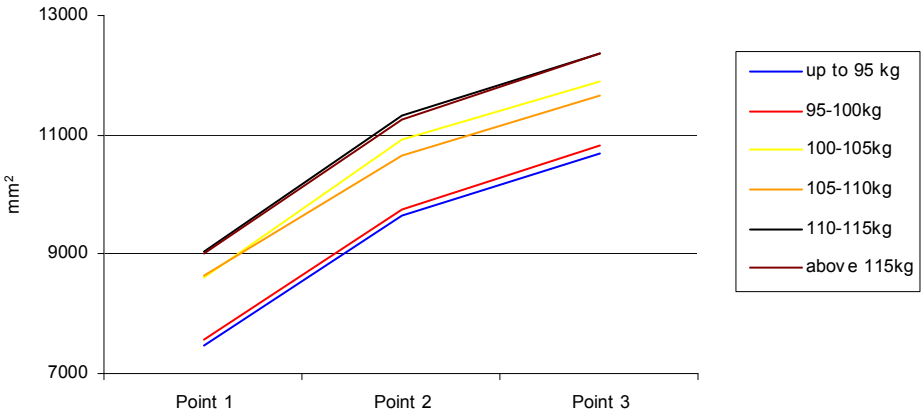



Fig. 3. Comparison of total belly area with respect to live weight

share and belly lean meat share do not achieve the same values and this difference rises with increasing weight.

It is obvious from Table 3 that there is statistically significant rising of total belly area with increasing weight in pigs, but only slight statistically insignificant increasing of meat area. The rising of total belly area from cut 1 to 3 is confirmed. Identical tendency was registered in all weight categories.

The same conclusion could be done for belly meat area as well. In comparison of increasing surface through percentage difference among monitored groups, if the group with live weight up to 95 kg would be considered as 100%, then average belly areas increased with increasing live weight into 101.1, 113, 111.2, 117.7 and 117.2%. Valuables of 102.3, 108.9, 105, 109.5 and 109.1% were determined for average meat areas from belly cuts. It is obvious that belly area rises with increasing body weight. The rising of meat area with increasing body weight is slower (Fig. 2).

It was also confirmed that belly lean meat area share decreases with increasing weight, especially in pigs up to maximum of live weight 105kg. Subsequently when higher live weight, the lean meat share dramatically does not decrease and the belly meat part retains the same meat and fat content.

Concerned the meat and fat deposition in individual cuts 1–3 (Figs 3–5) one could say that there were obtained differences in pigs with low weight and higher lean meat share in comparison to ones with higher weight and lower lean meat share. This result is in harmony with Kopecký et al. (1972), Vališ et al. (2005) and others.

Gráčik et al. (1986) found out that meat part shares decrease with increasing weight, but in case of belly meat part its percentage is increasing. Achieved values exceeded 20%. This conclusion was not confirmed in this work. The belly share from carcass was about 18% and did not increase with increasing weight.

## CONCLUSIONS

With increasing weight within monitored group in pigs

– there is not rising belly content in the carcass, percentage rising in EU-belly as well as in total belly part is the same,

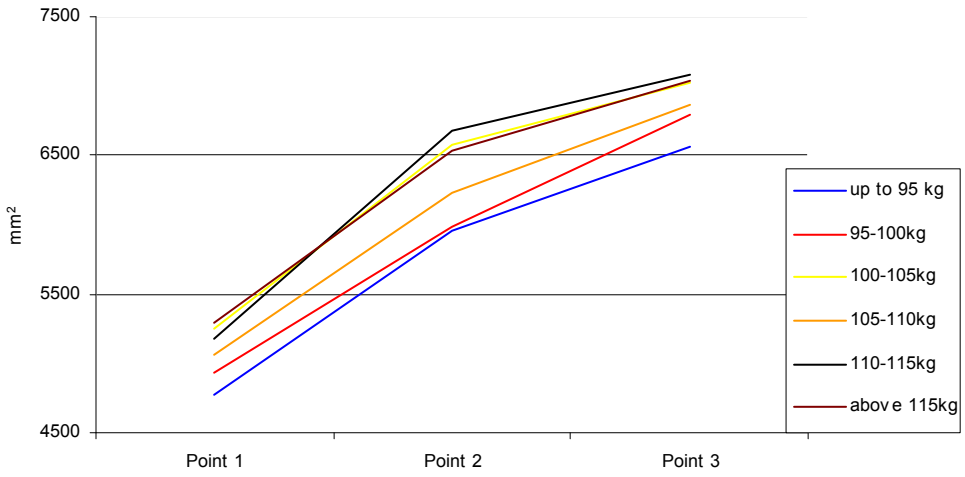



Fig. 4. Comparison of total belly meat area with respect to live weight

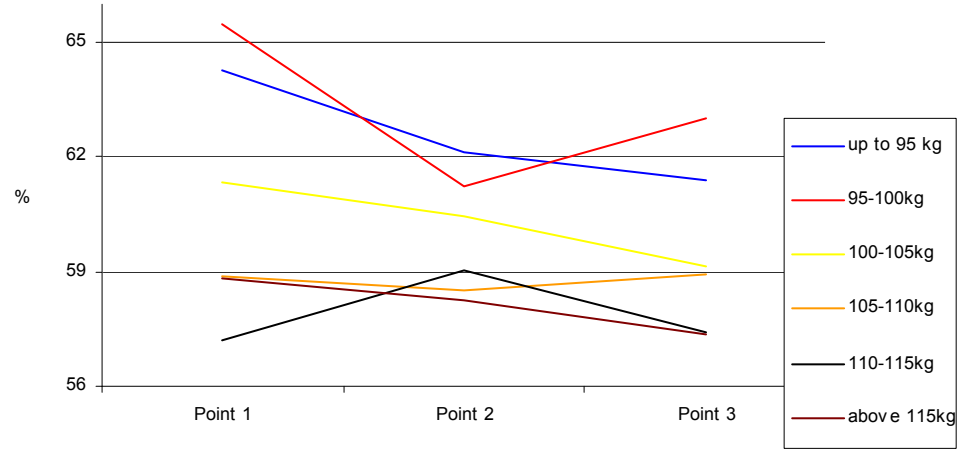



Fig. 5. Comparison of lean meat share in belly with respect to live weight

– rising of total lean meat in belly is substantially lower, belly lean meat share decreases,
– lean meat share in carcass as well as in belly do not achieve the same values, differences between them increase,
– there is statistically significant rising of total belly-area but only slight statistically insignificant rising of belly meat-area,
– arising of total belly area from cut-1 to 3 is confirmed and this tendency is identical in all weight categories,
– arising of belly area is more higher than belly meat one, lean meat share is decreasing especially up to 105kg of live weight, then there is no dramatically decrease of lean meat share and belly meat part retains the same meat and fat content,
– it was confirmed different meat and fat deposition in individual cuts (1–3) in animals with different carcass body weight.

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STUPKA, R. – ŠPRYSL, M. – ČÍTEK, J. – TRNKA, M. – OKROUHLÁ, M. – KUREŠ, D. (Česká zemědělská univerzita, Fakulta agrobiologie, potravinových a přírodních zdrojů, Praha, Česká republika):

**Analýza utváření jatečné partie bok ve vztahu k dosažené jatečné hmotnosti prasat.**

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Do pokusů bylo zařazeno 194 prasat-finálních hybridů běžně používaných kombinací křížení v ČR při vyrovnaném pohlaví. Cílem bylo posoudit utváření masné partie bok z pohledu celkového zastoupení v jatečném těle, utváření boku a zastoupení masa v závislosti na dosažené hmotnosti.

Bylo prokázáno, že s narůstající hmotností v rámci sledovaného souboru prasat nedochází k vyššímu zastoupení podílu boku v JUT, přičemž došlo ke shodnému procentuálnímu nárůstu u boku celkem a boku EU. S rostoucí hmotností dochází dále k výrazně nižšímu nárůstu absolutní hodnoty masa v boku (2.05 kg/95 kg, resp. 2.33 kg/115 kg a více), snižuje se procentuální podíl masa v boku (55.68 %/95 kg, resp. 52 %/115 kg a více). Podíl masa v JUT a podíl masa v boku nedosahují shodných hodnot a se zvyšující se hmotností dochází ke zvyšování tohoto rozdílu. S narůstající hmotností prasat dochází ke statisticky významnému nárůstu celkové plochy boku (9 274 $mm^2$/95 kg, resp. 10 869 $mm^2$/115 kg a více), ale pouze k mírnému, statisticky nevýznamnému nárůstu plochy masa (5 766 $mm^2$/95 kg, resp. 6 291 $mm^2$/115 kg a více), potvrzuje se růst celkové plochy boku od řezu 1 do řezu 3. U všech hmotnostních kategorií byl zaznamenán shodný trend, tj. s narůstající hmotností těla dochází k vyššímu nárůstu plochy boku, ale zároveň k pomalejšímu nárůstu plochy masa, dochází k poklesu podílu masa, a to především do živé hmotnosti cca 105 kg. Následně již nedochází k výraznému poklesu podílu masa a masná partie bok si udržuje v rámci sledované hmotnosti stejné zastoupení masa a tuku. Bylo potvrzeno rozdílné ukládání masa a tuku na jednotlivých řezech u zvířat s různou hmotností.

prase; bok; hmotnost

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