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INVESTIGATION OF THE RELATIONSHIP BETWEEN MEAT QUALITY, MARBLING, AND LEAN–FAT RATIO

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1 INTRODUCTION

Throughout human history, meat has played a central role not only from a nutritional/physiological standpoint but also socially, culturally, and economically. Its production and consumption have always adapted to the living conditions, technologies, and demands of the age; the meat industry and animal husbandry have continually sought to ensure adequate quantity and quality. Until the 1970s, the aim was to maximize fat yield, in line with then-prevailing patterns of work and diet. Thereafter—especially in developed societies—demand shifted from fat to lean meat; breeding and feeding were redirected toward achieving higher lean content.

In response, the European Union introduced the SEUROP system in 1981, a uniform, ostensibly objective carcass-yield classification for cattle, pigs, and sheep. In Hungary, implementation proceeded gradually from the late 1990s and became mandatory upon EU accession, forming the basis of live-animal pricing. It is important to note that SEUROP does not assess quality per se, but quantitative parameters (the lean–fat ratio); it is, in essence, a classification procedure. From the 2000s onward, another shift occurred: a quality-oriented approach began to supplant the purely quantitative perspective. Consumers worldwide—including in Hungary—have increasingly sought meats of higher gastronomic value with favorable sensory attributes.

In Europe, SEUROP still primarily measures yield and overlooks the complex, multidimensional characteristics of meat quality. By contrast, several major market players (the USA, China, Brazil, Argentina, Australia, Japan, and South Korea) evaluate quality parameters—in particular intramuscular fat (marbling)—in addition to yield indicators, which strongly influence eating quality, pricing, and export potential.

However, in current European practice it is not yet fully understood how SEUROP's lean–fat ratio and fat-cover classification relate to meat marbling and to sensory and quality parameters more broadly.

A deeper understanding of the relationship between meat quality and carcass-yield parameters is not only scientifically warranted but also of direct economic relevance. The growing demand for quality meats creates new opportunities for livestock production and the meat industry, while bringing sustainability, efficiency, and competitiveness to the fore. To reliably differentiate quality meats from mass-produced products, scientifically grounded, objective, and reproducible evaluation systems are required—systems that take into account international trends, the latest literature, and differing grading practices.

2 OBJECTIVES

Over recent decades, an ambivalent shift has been observed in consumers' preferences regarding meat: from a nutritional-science perspective, low-fat meats have come to the fore, while from the standpoint of sensory experience an adequate fat content—especially the presence of intramuscular fat (marbling)—remains desirable. This duality is reflected in different ways in the design and application of international meat-grading systems.

The aim of this study is to examine to what extent the SEUROP grading system, widely used in Europe, reflects consumers' expectations of sensory quality, with particular emphasis on marbling. To this end, alongside objective measurements I also employed several subjective (sensory) methods, whose reliability and reproducibility were ensured by involving trained assessors and using international visual reference charts.

While statistical methods are used to process the results, my primary goal is to evaluate differences (variances) among the examined parameters from a meat-science perspective.

A further objective is to determine whether any parameter evaluated by SEUROP shows a significant relationship with consumer-perceived sensory quality—especially marbling. I also aimed to identify where and by what sampling method measurements most effectively predict the meat's true eating quality with respect to marbling.

The purpose of my research is not to reject the SEUROP system, but to conduct a science-based critical assessment that may contribute to its further development and to better alignment with consumer expectations.

3 MATERIALS AND METHODS

3.1 Materials

3.1.1 Pork

The experiments were performed on boneless pork loin. In the case of pork, the samples originated from half-carcasses graded S, E, U, R, and O. The animals came from the same live-animal holding facility, were raised under identical feeding and housing conditions, and were of the same breed (Hungarian Large White), age (36–39 weeks), and sex (barrows). The number of samples was S: 27, E: 24, U: 16, R: 18, and O: 18, with two pork loins taken from each half-carcass. Slaughter at the abattoir took place under identical conditions. The examinations were carried out on the third day post-slaughter.

During the experiments, each loin was cut into four parts and, starting from the collar/neck end (tarja) toward the ham end, the sections were labeled 1–4. The four equal-length (15 cm) loin sections were then sliced into 2 cm thick chops.

3.1.2 Beef

The experiments were performed on boneless beef striploin (sirloin). For beef, the samples came from fore- or hind-quarters targeted to R and O conformation classes and belonging to fat cover classes 1, 2, 3, 4, and 5 (f1: 21 pcs, f2: 22 pcs, f3: 24 pcs, f4: 26 pcs, and f5: 21 pcs). In evaluating the data, only the fat-cover classes were taken into account. The animals came from the same farm, were raised under identical feeding and housing conditions, and were of the same breed (Hungarian Simmental), age (21–24 months), and sex (heifers). Slaughter at the abattoir took place under identical conditions. The examinations were carried out on the fifth day post-slaughter.

During the experiments, the striploin was divided into three equal portions and sliced to a thickness of 2 cm. Numbering was analogous to the pork loin, but with labels 1–3.

3.2 Methods

3.2.1 Marbling

Marbling was assessed visually in a professional setting on a 1–5 scale by a panel of ten experts, using the National Pork Board standard for pork and the USDA Meat Grading Scale for beef.

3.2.2 Sensory evaluation

Sensory evaluation of meat quality was conducted under standardized conditions. Samples were cooked without seasoning to a uniform core temperature of 72 °C, then served warm and coded.

A trained panel of ten performed the evaluation according to the relevant protocols. Each attribute was rated on a 10-point scale, where higher scores indicated better quality. The following sensory attributes were assessed:

- **Texture (firmness)**: resistance of the meat during biting and chewing
- **Juiciness:** amount of juice released during chewing; perceived succulence
- **Fatness:** perceived fattiness of the meat
- **Flavor:** basic meat flavor and its intensity
- **Overall impression:** general palatability and overall effect as judged by the panelists

3.2.3 Instrumental texture measurement

Firmness, i.e., shear force, was measured using a TA.XT2i texture analyzer (Stable Micro Systems) fitted with a Warner–Bratzler blade. Meat slices cooked to a core temperature of 72 °C were blotted with filter paper and cooled to room temperature (20 °C). Cylindrical cores 11 mm in diameter were cut perpendicular to the muscle fibers, and maximum shear force (F_{max}, N) was measured perpendicular to the fibers.

3.2.4 Dry matter content

Determinations were performed according to standard MSZ ISO 1442:2000.

3.2.5 Water-holding capacity

Water-holding capacity was determined using the method of Grau and Hamm.

3.2.6 Cooking loss

Slices were weighed, then cooked individually on a contact grill to a core temperature of 72 °C, monitored with a probe thermometer. After cooling to room temperature and blotting, they were reweighed. Cooking loss was calculated as the difference between initial and post-cooking mass, expressed as a percentage.

3.2.7 pH measurement

After sample preparation and instrument calibration, pH was determined at the measurement points in accordance with ISO 2917:2018.

3.2.8 Color measurement

Sample color was measured with a Minolta CR-200 handheld colorimeter on freshly exposed (cut) meat surfaces.

3.2.9 Statistical evaluation

Objective instrumental and sensory results were compared with the grading categories and with visually determined marbling. The analysis was conducted on two levels: between classes (pork: S–E–U–R–O; beef: f1–f5) and between positions (pork: 4 sections; beef: 3 sections).

The goal of the between-class comparison was to determine how well the SEUROP classification or fat cover predicted marbling. By analyzing quality parameters (texture, juiciness, fatness, etc.), we sought variables suitable for modeling marbling.

The between-position comparison served to identify representative sampling points—that is, where it is advisable to measure the individual parameters.

Effects were evaluated by analysis of variance with two or three grouping factors. Class means were calculated, deviations were tested with an F-test, and where significant differences occurred, Tukey's pairwise comparisons were performed to identify differences among groups.

Class means were plotted (together with positional data), and a line was fitted along the categorical axis to estimate the relationship; the linear model equation and coefficient of determination (R^2) were reported. Subsequently, class means were transposed to the corresponding marbling values and displayed in a scatterplot with a fitted trendline and R^2.

In addition, instrumental and sensory texture measurements were compared and plotted, as were the relationships between dry matter content and juiciness for pork and beef. Conclusions were drawn based on these results.

4 RESULTS

The research succeeded in elucidating in detail the relationship between the SEUROP system and the sensory quality attributes expected by meat consumers—especially marbling. The applied methodology enabled a comprehensive assessment of meat quality.

The findings clearly supported the hypothesis that, while the SEUROP system is an appropriate tool for the standardized evaluation of carcass yield, it is only of limited suitability for fully and accurately predicting the sensory quality of meat.

These results contribute to the scientific discourse emphasizing the need to further develop meat-quality evaluation systems based on carcass yield and fat-cover grades, with particular attention to incorporating sensory parameters.

It was established that, in both pork and beef, quality class is associated with marbling; in pork, marbling increases as quality class decreases (S → O), whereas in beef marbling increases with higher fat-cover classes (Class 1 → Class 5).

Another outcome of the study is that, based on the sampling and analytical protocol used, sampling points can be identified that predict true eating quality with high accuracy without additional processing steps. Thus, beyond its theoretical value, the study provides a practical contribution to modernizing meat-testing methods. For the pork loin and beef striploin samples examined, I considered it important to localize those regions where texture and color measurements can determine quality class—and thus marbling—with high confidence. Based on the results of these targeted measurements, the aforementioned measurements should be taken, for pork loin, from the section near the collar/neck end (tarja), and for beef striploin from the third nearest to the ribeye end.

4.1 Summary of results for pork loins from different SEUROP carcass-yield classes

SEUROP does not directly grade marbling; therefore, supplementary measurements are required for gastronomic (culinary) grading. Texture showed a dual pattern: fattier items may be less favorable on the first bite yet more favorable with prolonged chewing; thus the consumer experience may diverge from the “hardness” score. Juiciness tended, on average, to decrease with increasing fat ratio, although medium fatness was often judged more favorable. Perceived fattiness is not linear: high fat content can melt out during heating, whereas with proper processing less fatty meat can still be enjoyable. There is no clear, monotonic relationship between flavor and SEUROP class; higher marbling does not necessarily improve flavor and may even accentuate “heavy” notes. Overall impression does not necessarily improve with marbling, because texture and juiciness can offset it. Instrumental shear force corresponded well with sensory texture, enabling calibration of panel ratings against physical parameters. Dry matter increased with marbling and water-holding capacity weakened, mostly moderately; cooking loss did not separate sharply between classes; the practical significance of pH and color parameters beyond a* was limited.

4.2 Summary of results for beef striploins from different SEUROP fat-cover classes

In the striploin samples, there was a strong, consistent relationship between SEUROP fat-cover class and the intramuscular fat content of the longissimus dorsi. As the external fat layer thickened (from Class 1 to Class 5), marbling increased. This means higher-class, fattier striploins generally contained more intramuscular fat. Based on the measurements, objective instrumental tests performed at the ribeye end (anterior third) of the striploin—particularly texture assessment and color measurements—effectively distinguished among classes. Practically, therefore, it is advisable to complement traditional visual grading with the measurement of intramuscular fat when classifying beef, as this allows a more accurate prediction of consumer eating quality.

According to the sensory tests, the panel rated the moderately fatty (Class 3) striploin samples most favorably. On average, this category showed higher lightness (L*) and lower redness (a*) than either leaner or extremely fatty meats. This suggests that moderate fat cover balances first-bite tenderness with chew-down tenderness: strongly fatty meats may be firmer on the first bite yet become more tender during chewing, whereas leaner meats are initially soft but dry out more quickly. In summary, in beef, increasing fat cover clearly increased marbling and, consequently, altered sensory parameters. In my data, the moderately fatty striploin (Class 3) produced the most favorable overall impression, which was clearly reflected in the objective color metrics as well. Based on these observations, it is advisable that beef grading protocols complement SEUROP evaluation with measurements of marbling and key color parameters (L*, a*), as these better reflect consumer expectations and the eating experience.

5 CONCLUSIONS AND RECOMMENDATIONS

Relationship between pork SEUROP grading and marbling.

Based on the investigations, **there is a significant, linear relationship** between the SEUROP quality classes—derived from the lean–fat ratio of pork half-carcasses—and the intramuscular fat content (marbling) of the longissimus dorsi (loin). **As carcass fat content increases** (i.e., moving from S toward O), **the degree of marbling increases proportionally**. Consequently, pork with weaker SEUROP grades (fattier) is generally much more marbled. This is an important scientific finding, as it shows that the SEUROP system—traditionally reflecting only carcass yield—does, to some extent, also convey information about internal fat distribution.

Relationship between beef fat-cover classes and marbling.

I demonstrated a **strong association** between the 1–5 fatness scale (SEUROP fat cover) and beef marbling. Striploins from quarters with higher fat-cover grades typically exhibited higher marbling (more intramuscular fat). Thus, as external fat cover increases, the proportion of fat-interlaced areas in the meat also rises.

Practical recommendation.

During abattoir grading—considering SEUROP class in pigs and fatness in cattle—it is possible to infer expected marbling, aiding the prediction of quality categories.

Within-loin marbling in pork is homogeneous.

Examinations of the porcine longissimus showed **no statistically demonstrable differences in marbling among different sections of the loin**. Intramuscular fat content measured at both the collar/neck (anterior) and ham (posterior) ends was similar; across the four equal sections, marbling was practically identical. Therefore, loin marbling is **approximately homogeneous,** and a single measurement point (e.g., at either end of the short- or long-loin) may suffice for grading or quality control.

Practical recommendation: In pork, the sampling location is not critical for marbling assessment—any cross-section from the loin yields a reliable picture of intramuscular fat distribution along its length.

Marbling along the beef striploin is uniform.

Similarly to pork, **no significant differences in marbling** were found among the three sections of the striploin. The mean marbling of the anterior (ribeye side), middle, and posterior (round/ham side) sections was nearly identical, so marbling distribution can be considered homogeneous along the entire striploin. This indicates that intramuscular fat distribution can be characterized by a single, standardized measurement location (e.g., at the ribeye-facing cut surface).

Practical recommendation: For beef grading, one measurement point—at the ribeye (rostélyos) end or at the round-facing end of the striploin—is sufficient for an objective appraisal of marbling, as these are representative of the whole muscle.

Effect of intramuscular fat on pork texture (firmness).

According to the tasting panel, sensory texture (bite/chew tenderness) of pork loin **deteriorates as fat content increases**. Loins in the S–E–U classes (higher lean content, i.e., leaner) were softer on first bite, whereas meat from fattier classes (especially R and notably O) was significantly firmer. Meat from fatter half-carcasses required greater force to bite, resulting in lower sensory texture scores. This suggests that pork with higher fat content—graded less favorably in SEUROP—has a firmer first-bite texture, which may challenge the consumer experience.

Beef fatness and firmness.

A similar trend was observed in beef: with increasing fat cover, **sensory firmness scores decreased.** Beef in f1 (very lean) received the highest texture scores (i.e., felt softest on first bite), while fatter f4–f5 striploins scored progressively lower, indicating increased firmness. Thus, in beef as well, higher fat content initially impairs first-bite tenderness.

Conclusion: For both pork and beef, higher-fat (lower-graded) meats are harder to initiate chewing than leaner meats, and this appears as a lower texture score in traditional panel evaluations.

Paradoxical "dual effect" of fat on chewing (pork).

Although fattier pork is firmer at first bite, the data highlight an important practical phenomenon: higher intramuscular fat can **facilitate chewing and improve perceived tenderness as mastication proceeds**. In fattier (R and O) loins, fat layers embedded among fibers allow the fibers to slide and separate more readily during chewing, reducing the sustained effort required. Because panel scoring focused primarily on first-bite firmness, this favorable "succulence/crumbly" character of fatty meat was only partially captured.

Practical implication: Consumers may often perceive fattier meat as "softer," which actually reflects easier chew-down rather than initial bite tenderness. Sensory protocols should therefore evaluate first-bite firmness and chew-down tenderness separately to capture true eating quality.

Similar dual effect in beef.

The same two-phase texture behavior appeared in beef. Leaner (f1–f2) steaks were extremely soft on first bite, whereas fattier (f4–f5) steaks were distinctly firmer initially. However, fattier meats **were less chewy overall and broke down better during continued chewing.** In terms of consumer experience, richly marbled f4–f5 meats provided the most favorable overall texture throughout consumption, despite receiving low firmness scores for the initial bite.

Conclusion: Beef texture assessment should also address both initial bite and longer-term chew-down; these can vary in opposite directions as fat content changes.

Juiciness versus fat in pork.

Sensory juiciness of pork loin decreased as carcass fat content increased. The panel **perceived higher juiciness in lean S and E classes**, while scores dropped in U and O. **Interestingly, R-class pork was judged, on average, the most juicy** within the practically relevant range (S–R), in line with expert practice. Moderately fatty meats (like R) retain enough moisture during cooking, and a small amount of rendered fat helps prevent drying.

Practical recommendation: Producers should note that the leanest, virtually fat-free meat is not necessarily the juiciest; moderate fat levels may yield better consumer-perceived juiciness.

Effect of fatness on juiciness in beef.

Across the 1–5 fat-cover classes, juiciness did not differ markedly—statistics indicate fat cover does not significantly influence perceived juiciness in beef. This suggests that water-holding capacity and juiciness depend primarily on other factors (e.g., aging, fiber architecture), not merely on marbling. Nevertheless, moderately **fatty Class 3 showed balanced cooking loss and good juiciness perception.** In tastings, moderately fatty beef (Class 3) offered the best-rated succulence and overall effect, compared with very lean (f1–f2) or extremely fatty (f5) beef.

Conclusion: For consumer juiciness, moderate fat cover in beef can be considered optimal.

Sensory fattiness (fatty taste) versus actual fat content in pork.

Surprisingly, perceived fattiness during tasting did not correlate closely with classification by carcass fat ratio. **A fattier meat may taste less "fatty,"** while a leaner meat can taste fatty. Separate statistical analysis showed R-class pork differed significantly from S, E, U, and O: R received the most favorable fattiness ratings. In carcasses with 45–50% lean (moderately fatty), the fat-to-lean balance is optimal: during cooking, much of the fat renders out, so the meat does not taste aggressively greasy, and the rendered fat protects against drying.

Practical takeaway: Carcass yield class is not a reliable predictor of consumer-perceived fattiness; targeted culinary techniques (heat intensity, temperature, searing, draining rendered fat) should be tailored to fat level.

Perceived fattiness and fat cover in beef.

A similar phenomenon was observed: perceived fattiness did not vary linearly with fat cover. For slightly fatty (f1–f2) and very fatty (f5) striploins, perceived fattiness did not change proportionally. Panel feedback indicated that **moderately fatty (f3–f4) meats were "most pleasant"**: enough fat rendered to prevent drying, without making the experience overly greasy.

Conclusion: Yield class is not a dependable proxy for perceived fattiness in beef either; specific culinary techniques are needed. Perceived fattiness arises from the interplay of marbling distribution, collagen quantity/quality, degree of aging, and the applied heat treatment.

Effect of intramuscular fat on pork flavor.

Results indicate that as marbling increases, **the classic "meaty" flavor of pork slightly diminishes** (a weak statistical relationship). Panels scored very lean loins (marbling level 1–2) as having more intense meaty flavor, while loins with around 2.5–3 marbling showed a slight decrease. **Explanation:** in higher-fat meats, fat-soluble flavor compounds become dominant, which can reduce perceived "meaty" intensity. For some consumers this is favorable, as many dislike the characteristic metallic/gamey notes of very lean meat. Overall, marbling correlated only weakly with overall flavor pleasantness**; there is no simple "more marbling = better flavor" rule.**

Conclusion: There is an optimal marbling range for best pork palatability; both very lean and very fatty meats differ in flavor profile, and preference depends on individual taste.

Beef palatability versus fat/marbling.

Tasting suggested the relationship between fat content and palatability is not directly proportional in beef either. U-class beef (moderately lean, good conformation) **received outstanding flavor scores,** significantly different from both leaner (S/E) and fatter (R/O) groups. This suggests that **cattle with moderate fatness and good muscle development produce the most flavorful beef**—marbling supplies enough flavor and juiciness without excessive external fat masking pleasant aromas.

Practical advice: For optimal beef flavor, producers should avoid both excessively lean and overly fat animals; intermediate, moderately fatty stock provides the richest flavor experience.

Quality classes and overall impression (composite consumer experience) — pork.

The SEUROP category **only moderately predicts overall sensory judgment** in pork. Although some association exists (e.g., O-class, fatty meats averaged lower overall impression than leaner ones), the correlation is weak; lean content alone is not a reliable indicator of consumer satisfaction. Considering **all sensory factors (flavor, juiciness, texture, fattiness), each declines only slightly as fat content increases,** and the overall impression likewise decreases only mildly toward weaker classes.

Conclusion: The current pork grading system (primarily based on lean content) does not adequately reflect complex meat quality; other factors important to consumer experience should be incorporated.

Fatness and overall impression — beef.

A clear preference emerged for moderate fatness. The tasting panel rated Class 3 (moderately fatty) striploin highest for overall impression; leaner (1–2) and fattier (4–5) meats scored lower on general liking. Too little fat can yield dryness; too much can feel heavy/greasy.

Recommendation: In beef evaluation and pricing, **Class 3 products should be highlighted** as the most consumer-friendly and flavorful.

Methodological note — objective instrumental prediction of marbling (pork).

My research confirmed that visually assessed marbling in pork can be successfully modeled using objective instrumental measures. In particular, Warner–Bratzler shear force (firmness) and the red color component (a*) showed strong relationships with marbling levels. For example, the most marbled loin samples (O class) near the ham end had higher shear-force values (indicating firmer texture) and were markedly redder and more yellow than leaner, higher-quality S/E classes. These objective differences effectively separated quality classes.

Practical recommendation: To supplement or substitute human panels, the industry can implement firmness testing and color measurement (especially a*) as predictors of marbling—and thus expected eating quality.

Optimal sampling locations for measurement methods.

I examined where on the muscle measurements are most effective. **In pork loin, the collar/shoulder end, and in beef striploin, the first third toward the ribeye (about 10–15 cm)**, proved most suitable for objective quality measurements (texture, color, etc.). At these points, classes can be distinguished without further processing.

Practical recommendation: Standardize sampling locations in meat examinations—e.g., for pork long-loin, take samples from the shoulder/blade end; for beef, from near the ribeye—so results are comparable and reproducible, thereby improving grading reliability.

Improving meat grading — recommendations for practice.

In summary, current European grading systems **do not fully capture eating quality and should be supplemented.** I recommend that grading explicitly account for intramuscular fat—either via direct visual marbling assessment or reliable instrumental methods (e.g., meat redness, NIR spectroscopy, or imaging).

Recommendation to authorities and industry: Explore developing a comprehensive grading system that integrates objective meat-quality metrics (marbling, pH, water-holding capacity, etc.) alongside traditional yield indicators, to support the production and market differentiation of higher-quality, more flavorful meats.

6 NEW SCIENTIFIC FINDINGS

The six theses below summarize the results of the investigations presented in this dissertation. Their validity applies specifically to the **Hungarian Large White** pig breed and **Hungarian Simmental (Magyar Tarka)** cattle.

1. **Thesis: Sampling strategy for pork quality assessment.**

   Based on my investigations, **the rostral** (collar-side) **first 15 cm of the pork loin reliably represents the following quality parameters of the entire longissimus dorsi**, as ANOVA found no significant differences among loin sections in the parameters examined:

   - **Sensory: marbling, perceived fattiness;**
   - **Instrumental: dry matter content, water-holding capacity, cooking loss, pH, and the L*, a*, b* color coordinates.**

   Consequence: Comprehensive meat-quality evaluation can be performed—without additional technological intervention—at a sampling point that is anyway exposed during standard fabrication. Overall, applying a standardized sampling strategy improves the accuracy and efficiency of meat quality control.

2. **Thesis: Sampling strategy for beef quality assessment.**

   For beef striploin, the **rostral (ribeye-side) anterior third** reliably represents the following quality parameters of the entire *longissimus* muscle, as **ANOVA** revealed no significant differences among sections:

   - *Sensory:* marbling, texture, juiciness, perceived fattiness, flavor, overall impression;
   - *Instrumental:* texture, dry matter content, water-holding capacity, cooking loss, and **L***, **a***, **b*** color coordinates.

   Consequence: Comprehensive meat-quality evaluation can likewise be performed—without additional technological steps—at this routinely exposed sampling site. A **standardized sampling strategy** enhances the precision and efficiency of beef quality control.

3. **Thesis: Predictive capacity of the SEUROP system for complex pork quality.** My analysis shows that the currently used yield-based SEUROP classification has **limited predictive validity** for describing pork eating quality. SEUROP classes showed statistically demonstrable relationships with the following consumer-relevant variables:
   - *Sensory:* marbling, texture;
   - *Instrumental:* texture and **L***, **a***, **b*** color coordinates. However, **no associations** were detected with:
   - *Sensory:* juiciness, perceived fattiness, flavor, overall impression;
   - *Instrumental:* dry matter content, water-holding capacity, cooking loss, pH. **New contribution:** I propose augmenting the grading system with a **quality-oriented factor** that integrates these parameters to enable a **multidimensional** classification that better predicts consumer evaluation.

4. **Thesis: Predictive capacity of the SEUROP system for complex beef quality.** Similarly, for beef the fat-cover–based SEUROP classification exhibits **limited predictive validity** for eating quality. Fat-cover classes showed statistically demonstrable relationships with:
   - *Sensory:* marbling, texture;
   - *Instrumental:* texture and **L***, **a***, **b*** color coordinates. Conversely, **no associations** were found with:
   - *Sensory:* juiciness, perceived fattiness, flavor, overall impression;
   - *Instrumental:* dry matter content, water-holding capacity, cooking loss, pH. **New contribution:** I propose supplementing the system with a **quality-oriented factor** that integrates these parameters, enabling a **multidimensional** grading that better anticipates consumer judgments.

5. **Thesis: Perceived fattiness vs. carcass lean–fat ratio (pork).** My investigations demonstrated that, in pork loin evaluations, **perceived fattiness in the mouth is not associated** with the SEUROP lean–fat ratio. Statistical analyses revealed **no clear relationship** between yield class and perceived fattiness—thus a leaner and a fatter half-carcass alike may be perceived as “fatty” or “not fatty” by consumers. These observations support that meat quality is a **complex sensory phenomenon** only partly determined by chemical composition.

6. **Thesis: Perceived fattiness vs. carcass lean–fat ratio (beef).** In beef striploin, likewise, the **extent of external fat cover alone does not predict** perceived fattiness, because the **amount and distribution of rendered fat**, as well as the meat's **water content and connective tissue**, also shape overall perception. I found **no relationship** between the SEUROP lean–fat ratio and perceived fattiness in this case either. These results confirm that, due to the **combined effects of fat and water**, traditional classification metrics are **insufficient on their own** to predict the true consumer experience.

7 PUBLICATIONS RELATED TO THE TOPIC OF THE DISSERTATION

Surányi, József; Zaukuu, John-Lewis Zinia; Friedrich, László; Kovács, Zoltán; Horváth, Ferenc; Németh, Csaba; Zoltán, Kókai

Electronic Tongue as a Correlative Technique for Modeling Cattle Meat Quality and Classification of Breeds

FOODS 10 : 10 Paper: 2283 , 15 p. (2021)

Q1, IF 4,350

Surányi, József; Jónás, Gábor; Balla, Csaba; Németh, Csaba; Felföldi, József; Friedrich, László

Determination marbling and other quality characteristics of pork loin / Sertéskaraj márványozottságának és egyéb minőségi jellemzőinek vizsgálata

MAGYAR ÁLLATORVOSOK LAPJA 136 : 8 pp. 479-484. , 6 p. (2014)

Q4, IF 0,185

Jónás, Gábor; Visy, Anna; Dalmadi, István; Majzinger, Koppány; Krzyzewsky, Nóra; Barkó, Annamária; **Surányi, József**; Friedrich, László

Evaluation of the Effects of Electrical and Carbon Dioxide Stunning Methods on Quality Attributes of Pork Meat

APPLIED SCIENCES-BASEL 14 : 22 Paper: 10410 , 12 p. (2024)

Q2, IF: 2,7

Hussein, Khabat Noori; Csehi, Barbara; **József, Surányi**; Ferenc, Horváth; Kiskó, Gabriella; Dalmadi, István; Friedrich, László

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