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From fatted calf to food data – how to accomplish a representative sampling

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Introduction

It is a well-known fact that sampling as well as the analysis uncertainty influence the final analysis result, however, the work concerning development and optimization of methods has traditionally attracted the most attention. The reality is more or less worthless analysis results – in spite of quality-controlled methods – if the sampling is not representative for the basic material.

Within the food sector, a representative sampling is crucial for risk assessments [1]. Also for elaboration of valid nutrient labelling, or when the purpose is to calibrate indirect methods for quality-controlled food, the representative sampling is of the utmost importance.

The Danish Meat Research Institute (DMRI) has previously worked on obtaining up-to-date data on nutritive value in beef and veal [2, 3]. In the current EU project, TRIMSCAN http://trimscan.eu/, work is performed on test of a prototype for in-line determination of fat in trimmings from beef and pork. In both projects, planning and execution of a representative sampling have been essential. Broadly, the work has followed DS-3077 [4], which is a matrix independent standard, based on Theory of Sampling (TOS). The process is illustrated in Figure 1 showing the connection between sampling steps and sources of error, three governing principles (heterogeneity, variography, lot dimensionality reduction) and four sampling unit operations (mixing, particle size reduction, composite sampling, mass reduction) [4].

Case 1 – Nutritive value in beef and veal

Present data in the Danish food database Foodcomp (www.foodcomp.dk) have been gathered for many years, and within beef and veal the underlying data are slender and antiquated, e.g. were data for ”beef, silverside” established in 1981 based on three animals. For that reason, it was necessary to obtain up-to-date data to elaborate the compulsory nutritive declarations, documented as a representative average composition of the nutritive content.

Primary sampling

In the primary sampling, the composition of the population was estimated (heterogeneity) according to the classification characteristics weight, age, conformation class, fattening degree and colour, cf. Table 1 shown for cattle [2]. Based on this, eight average oxen (young bulls, young cows and cows) were selected. The annual distribution on each category of cattle was taken into account. The cattle breed Holstein-Friesian, representing the main part of cattle in the population (lot dimensionality reduction), was selected for all animals to be slaughtered.

Table 1. Primary sampling

Cattle chosen from the breed Holstein-Friesian, according to the European Union beef carcass classification system (EUROP). For weight, conformation and fat class the average value from the classification statistics is stated at the top while the selection interval is stated at the bottom in brackets.

Group	Category	Num-ber	Weight (kg)	Age (months)	Conformation class	Fat class	Colour class
CATTLE	**A – 2** (Young bulls)	2	**267.3 [250-275]**	**12-14**	**5.4 [O-/O]** (4-5)	**2.6 [2-3]**	**3**
	E – 6 (Heifers)	1	**279.6 [265-295]**	**20-27**	**5.7 [O-/O]** (4-5)	**3.2 [3-4]**	**3**
	D – 8 (Young cow)	1	**262 [242-282]**	**30-38**	**2.7 [P/P+]** (2-3)	**2.5 [2-3]**	**3**
	D – 9 (Cow)	4	**299 [280-310]**	**50-68**	**3.1 [P/P+/O-]** (2-4)	**2.7 [2-3]**	**3-4**

Conformation class: E, U, R, O, P. E extraordinary muscle fullness, P scanty muscle fullness. Supplemented by a 15-step scale.
Fat class: Layer of tallow estimated according to a scale in five classes, from 1, thin tallow layer to 5, thick tallow layer.
Colour class: Estimated according to a Danish scale in five classes, from 1, extra light, to 5, dark/yellow colour.

The carcasses were cut into specific cuts at the slaughterhouse, defined according to the product catalogue [5]. As an example is shown a cutting of back with bone and tenderloin in Figure 2 – cut from third thoracic vertebrae to sixth lumbar vertebrae. This cutting contains 19 partial cuts. Eight samples – one from each animal – were taken from each partial cut. The samples were pooled to one sample, which permitted a substantially larger amount of cuttings to form part of the collection of samplings.

Quality assurance of the pooling was documented for a lean and a fat beef cutting, respectively, as the chemical analyses were made for the pooled sample as well as for all the selected single samples from the animals for slaughter, which constituted the pooled sample [2].

Homogenization of cuts (Particle size reduction/mixing)

The samples were homogenized according to this procedure:

1. < 5 kg: homogenization twice in a mincing machine (Bizerba FW 70, 2 mm perforated disc).

2. 5-25 kg: homogenization in the bowl chopper (KILIA), see Figure 3. Layer of fat in the bowl and from the lid is scraped off and mixed with the sample during the mincing.

3. > 25 kg: parted into two parts of no more than 20 kg, homogenization in the bowl chopper.

Secondary sampling

Approx. 1 kg of sampling material was selected for further division. Small samples were picked, evenly distributed from the minced meat in the bowl – first from the outer edge of the circle and then from the inner circle. Then the minced meat was turned over, with the underside facing upwards. Similarly, from

the underside, small samples were selected evenly distributed, see Figure 4. For portions >25 kg, approx. 500 g were selected evenly from the two portions.

Homogenization of minced meat

The selected test material was homogenized in a mincing machine or in a blender (Grindomix, RetschGM 200, 8 sec. at 9.0 x 1000 rpm), and then mixed manually with a fork.

Tertiary sampling

A part of the homogenized sample was selected for analyses samples. The samples were kept in 50 ml plastic cups at -20°C until analysis.

The combined progress for the secondary and the tertiary sampling is shown in Figure 5.

Case 2 – Calibration and validation of the in-line fat analyser – TRIMSCAN

The aim of the sampling was to obtain representative samples for calibration and validation of the method for fat determination based on two widely different analysis principles – an in-line method based on measuring of magnetic induction (TRIMSCAN) and a traditional gravimetric analysis method (ISO 1443), which was used as a reference method.

The in-line fat analyser is developed to determine, automatically, the percentage of fat in trimmings from the slaughter of pigs and cattle. The products are primarily trimmings from irregular pieces of meat, as a result of deboning carcasses or special cuts. It is sold for e.g. sausage production and is usually settled according to the content of pure meat (lean). The recipient also uses the lean percentage for standardizing the fat percentage in the finished products, which is why the precision is important in this context as well.

The production of trimmings in the EU is large – approx. 14,000 t of pork and approx. 3,500 t of beef annually – meaning that an accurately estimated fat percentage is very important to the price.

Primary sampling

The following factors formed a part of the considerations at the primary sampling for calibration curves: product type, fat content, sample size, sampling volume, temperature etc. Two standard cuts were chosen from each species (cattle/pig) with a high and a low fat content, respectively, from which relevant compounds should be made.

All the cuts investigated were commercial standards (specified trimmings), delivered from cutting lines at Danish slaughterhouses in boxes (E2) of 25 kg.

Division of products/mixing of samples

Fat and meat products were cut into pieces of 5-6 cm^3 and weighed according to the table below to a calibration curve for pork. After careful, manual mixing in the box (E2), the surface and core temperatures were measured, and the sample was now ready to be measured at the fat analyzer.

Table 2. Calibration curve, pork

No.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Meat, g	25000	23200	21400	19600	17800	16000	14200	12400
Fat, g	0	1800	3600	5400	7200	9000	10800	12600
Fat, %	5	10	16	21	27	32	37	43

Secondary and tertiary sampling

Sampling of samples for chemical analyses was simple – the entire sample used for in-line measurement of the fat content was used, divided and selected as described in the first case.

Discussion

Case 1

The purpose of this investigation was to determine a representative average composition of the nutrient content of 157 cuts of beef and veal. Whether 8 animals are much better than 3 animals in representing the population can cause a discussion of the balance between the degree of heterogeneity and costs. Eight animals were chosen based on recommendations and guidance on procurement of data for foodstuffs' nutrient composition [6], supplemented with a statistical assessment [2]. In practice, it has previously been shown that 5 to 10 samples are sufficient to reflect the variation in most foodstuffs [6, 7].

The decision to pool the samples rather than analyse the samples separately was taken according to an evaluation of the sample variation being uninteresting in connection with elaboration of the nutrient declaration. In the database Foodcomp, it is usually also just a value for an average, which is stated. As mentioned previously, the pooling of the samples made it possible to include a large number of cuts in the sampling.

Case 2

The purpose of this sampling was to select representative samples for calibration and validation of the analysis method. The decision to produce relevant mixtures for the calibration curves according to two standard cuts with high and low fat content, respectively, was taken to eliminate the effect of different composition, apart from the fat content, e.g. the share of connective tissue. The effect of differences in the chemical composition is subsequent validated with ”real” by-products, procured directly from the slaughter line according to a well-considered sampling plan.

The chosen procedure allows repeated measurements with the in-line equipment at the same chemical analyses. Just as changes can be made for the distribution and trimming size in the at-line measurements.

Acknowledgements

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Figures

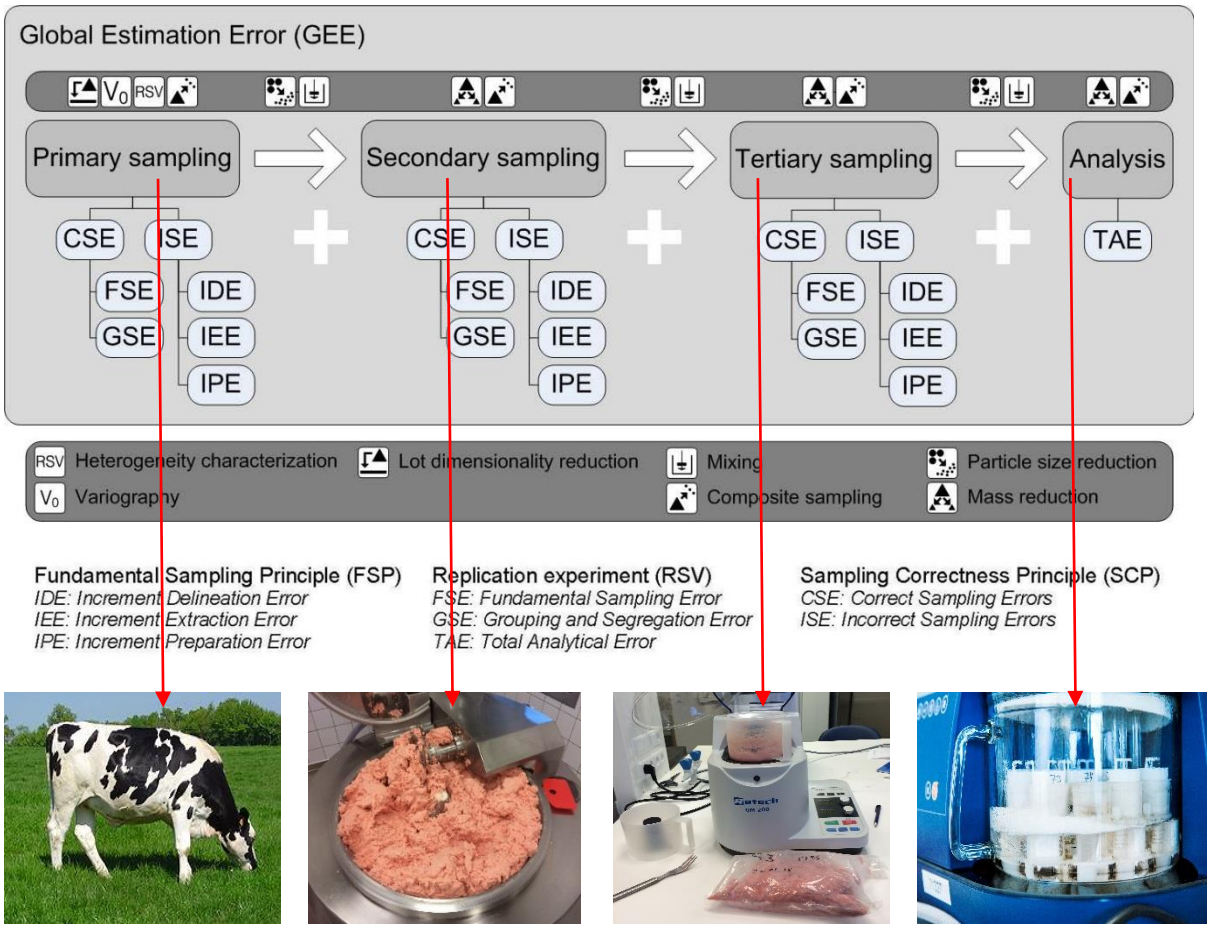


Figure 1. Matrix independent standard for representative sampling, mod. a. Dansk Standard (DS-3077) [4]

Figure 2. BEEF BACK
Back with bone and tenderloin, cut from third thoracic vertebrae to sixth lumbar vertebrae.

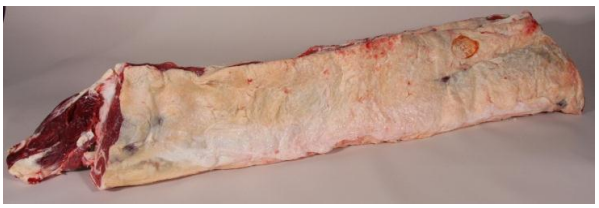


Figure 3. Bowl chopper, 30 L – *KILIA*

Figure 4. Secondary sampling

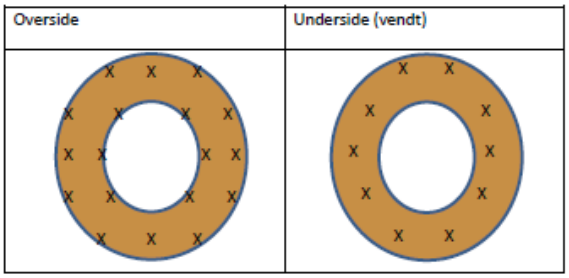
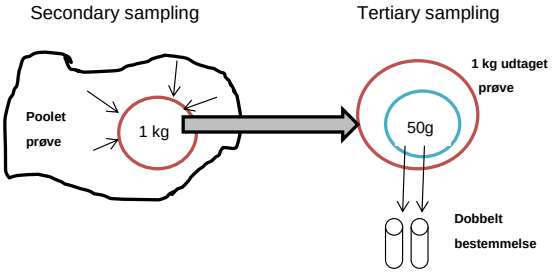


Figure 5. Sampling of homogenized sample



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