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ESSENTIAL ELEMENTS IN OFFAL FROM CATTLE, REINDEER AND CHICKEN

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I. INTRODUCTION

Meat and animal products are important for human nutrition. Traditionally all edible parts of slaughtered livestock were utilized as human food, but today there is a decline in offal consumption in Europe [1]. The animal products are usually rich in high-value nutrients such as protein, fat, vitamins and minerals. There are 16 essential minerals which must be supplied by diet so our body can function well [2]. Offal consumption could be a source for most of these minerals. However, not all minerals have beneficial effects if they are consumed. Certain heavy metals such as mercury, cadmium and lead may have an unfavorable influence on life. Unfortunately, these minerals tend to be accumulated in liver and kidneys [2]. There are several papers reporting on mineral content in offal from ordinary livestock, but few studies have compared the levels in reindeer with cattle and chicken. Therefore, the main purpose of this study was to increase knowledge about mineral content in offal from reindeer, cattle and chicken slaughtered in Norway.

II. MATERIALS AND METHODS

Offal samples from reindeer, cattle and chicken were obtained from commercial slaughterhouses in Norway. Heart, liver and kidney were sampled from reindeer and cattle, while heart and liver were collected from chicken. All samples were approved as food grade and were frozen immediately after slaughter. Approximately 10 kg of each organ type was shipped to the laboratory at Nofima. Still frozen, the samples were cut into approximately 1,5 cm thick slices. From each organ, the pieces were randomly mixed and spread on trays before freeze drying. The dry organs were ground to fine powder (Wilfa BL1200, Wilfa, Norway). Three homogenized samples, collected from different drying trays were analyzed for mineral composition by ICP-MS at Eurofins laboratory (Vejen, Denmark), according to method ISO 17294:2016. Minitab (version 21) was used for statistical calculations.

III. RESULTS AND DISCUSSION

To obtain representative average values for the 10 different minerals quantified in this study approximately 10 kg of each organ was dried and homogenized, which means the number of chickens sampled was higher than cattle. Freeze drying was applied to remove water from the samples. Among the dried sample organs, chicken heart had lower ($p<0.001$) dry matter content (19,8%) than all the other examined offal samples. At the other end was liver from reindeer and cattle which had more than 29% dry matter. Since liver may contain up to 15% glycogen the higher dry weight found for these samples could be due to carbohydrates [2]. Liver from reindeer was high in copper, almost twice as much as was found in the bovine liver, Table 1. Though, these copper measurements showed a relatively wide range. The present result was also higher than previously found in liver from wild, hunted reindeer in Norway [3]. Even the reindeer heart had higher ($p<0,01$) concentration of copper than were measured in the hearts from cattle and chicken. The reindeer liver had higher level ($p<0,01$) of selenium than the bovine liver, but similar as chicken. Liver from chicken turned out to be the best source of iron ($p<0,001$) among all organs in this study. Iron concentration was twice as high as was found in the bovine liver, which agrees with previous studies [2]. Zinc is crucial for our immune cells and necessary for almost 100 enzymes in our body. The analysis detected substantial quantity of zinc in the bovine liver, and slightly higher than reported previously [2,4]. Although the numerical value for bovine liver may seem higher than chicken or reindeer, there was no significant difference. However, chicken hearts had more ($p<0,001$) zinc than hearts from reindeer and cattle. Magnesium is vital for muscle function and energy production. Not surprisingly, higher ($p<0.05$) levels of magnesium were quantified in the heart samples than kidney.

Mercury is one of the heavy metals without beneficial health effects. Unfortunately, 0,53 mg/kg mercury was quantified in the reindeer liver, while the kidney contained 2,1 mg/kg mercury. These concentrations are at the same

level as was reported for reindeer slaughtered in Russia [5]. Mercury was detected in offal from cattle and chicken as well, but at much lower concentrations, (results not shown). Lead and cadmium were quantified at very low concentration in kidney and liver, but not in the hearts. Nickel was not detected in the samples studied.

Table 1. Dry weight concentration (mg/kg) of essential minerals found in offal obtained from cattle, reindeer and chicken. Mean values of 3 blended samples and standard deviation.

Sample	Fe	Cu	Mg	Se	Zn
Cattle					
Heart	163 ± 29	10 ± 1	873 ± 117	0,71 ± 0,2	51 ± 7
Liver	313 ± 83	187 ± 15	757 ± 40	0,64 ± 0,1	200 ± 76
Kidney	200 ± 26	12 ± 2	630 ± 78	3,73 ± 0,1	71 ± 14
Reindeer					
Heart	213 ± 25	14 ± 1	950 ± 21	0,97 ± 0,2	53 ± 7
Liver	443 ± 59	350 ± 106	743 ± 15	3,50 ± 1,3	133 ± 21
Kidney	490 ± 66	10 ± 1	550 ± 181	2,43 ± 0,2	62 ± 13
Chicken					
Heart	147 ± 6	12 ± 1	877 ± 23	1,33 ± 0,1	95 ± 3
Liver	690 ± 0	12 ± 0	790 ± 17	2,70 ± 0,2	100 ± 0

IV. CONCLUSION

The present study has shown that offal is a good source of essential minerals, although cadmium, mercury and lead were quantified in some of these organs. Reindeer liver was identified to contain more copper and selenium than bovine liver.

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