Veterinary-Sanitary Inspection of the Upland Game Meat from the Yakutian Habitat

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Abstract. This article presents the results of the veterinary-sanitary inspection and research of upland game carcasses. During the primary inspection, we paid special attention to the presence of abnormal changes typical of infectious and invasive diseases, based on the standard rules for inspecting the meat of domestic fowl. We also took into consideration the nature of injuries, dehematizing levels, product quality, and freshness. The preservation of the upland game meat depends not only on the rapid removal of intestines from carcasses but also on the type and area of injuries, and the level of dehematization. The study mater for this research is represented by the carcasses of upland game, namely their muscle tissues. During the research, we used organoleptic, physical, chemical, bacteriological, pathomorphological, and mathematic methods. During the organoleptic tests, the highest appraisal of upland game products on a 9-point scale was within the range of 8.4-9, which complies with the standards. The content of amino-ammonia nitrogen was 0.78±0.01. The primary protein breakdown product test showed that the fresh meat produced clear stock without flaking. The fat acidity value test showed an increase from 0.8±0.01 to 3.9±0.01 mg/KOH; the fat peroxide value increased from 0.01±0.01 to 0.74±0.5% J. The pH value varied from 5.99±1.79 for fresh meat to 7.70±0.01 for stale upland game meat. The microbiological tests did not find any pathogenic germs, including salmonella and Listeriamonocytogenes bacteria.

1. Introduction
Currently, the meat of wild game animals plays a significant role in providing the people of the Far North with food in the context of import substitution. In the Republic of Sakha (Yakutia), wild game birds can be found in areas that are not designated for agriculture. They feed on woody and grassy plants and do not require special care or premises to breed while yielding significant amounts of specialty foods.

The Republic of Sakha (Yakutia) has a large territory, and it is rich in upland game, which is a traditional resource in the Far North, where hunting is one of the main economic activities of the population. Its dietary value plays a significant role in survival in extreme conditions. The upland game includes wood grouse, black grouse, snow grouse, and hazel grouse that inhabit the southern and southwestern tundra and wooded tundra regions of Sakha (Yakutia). These are nonmigratory birds, and they do not fly away for winters.
2. Relevance
The increasing demand for upland game meat on the internal market of the Republic of Sakha (Yakutia) conditioned the need for an objective evaluation of its quality and safety.

The provision of the populace with meat and meat products through local production and the overriding of import dependence are among the prioritized goals of the country's agricultural sector. One of the key factors of meat production output and efficiency increase is the improvement of product quality.

3. Statement of problem
The goal of this research is the veterinary and sanitary inspection of upland game meat from the Republic of Sakha (Yakutia).

To that end, we set forth the following objectives:
1. Performing a primary veterinary-sanitary inspection of upland game carcasses with the further evaluation of organoleptic, physical, and chemical properties of the meat.
2. Determine the level of microbial contamination of the meat.

4. Theory
We researched organoleptic, physical, chemical, sanitary, and microbiological properties of upland game organs and tissues to check if these are contaminated by *Escherichia coli, Salmonella gallinarum, Salmonella pullorum, Staphylococcus aureus* и *Clostridium perfringens* that are dangerous for people’s health.

The study matter for this research is represented by the carcasses of upland game, namely their muscle tissues.

The research was carried out using the following methods:
1) Organoleptic: the study of the meat’s appearance, the texture of muscle tissue and fat, test boiling, and the evaluation of the organoleptic parameters of the boiled meat and the stock.
2) Physical and chemical tests: quantitative or qualitative chemical reactions with specific reagents, tests for fats, some vitamins, and other substances.
3) Bacteriological: the study of bacterial culture parameters using the pure growth identification methods and laboratory animal infection;
4) Pathomorphological: autopsy methods, identification of specific changes in internal organs and tissues of the upland game, sampling organs for microbiological research.
5) Mathematical: the processing of the digital data obtained during the experiments using the variation statistics method based on the Student's validation test implemented in the Microsoft Excel XP computer software [1,10,16,17,18].

5. Research findings
The results of the research conducted helped develop and approve the guidelines for the Veterinary-Sanitary Inspection of Upland Game Meat During Its Bagging and Sales. Besides, we published the guidelines for the Microbiological Control of the Upland Game Meat intended for the students of veterinary medicine of the Arctic SAU majoring in 36.03.01 Veterinary-Sanitary Inspection, 06.03.01 Biology, 36.04.01 Veterinary–Sanitary Inspection, 36.05.01 Veterinary, and the attendees of the Institute for Continuing Supplementary Vocational Education.

6. Results
The first treatment of the shot birds was carried out in the field. The key manipulations to remove feathers that impact the quality of carcasses were performed by hand.

The exterior inspection of the upland game carcasses did not find many pathological changes.

After the visual veterinary-sanitary inspection of the upland game carcasses, we studied their organoleptic, physical, chemical, and microbiological properties.
According to the fresh meat tests, the upland game carcasses varied across all of the organoleptic parameters.

To this end, we selected samples (carcasses) from homogeneous batches (of the upland game) at various times within a year and eviscerate them after 2 hours and 10-12 hours after the killing, which produced carcasses of varying freshness. We studied a total of 45 samples and carried out 86 analyses.

The data on organoleptic parameters of the fresh upland game meat are almost identical: the only difference is the coloration of the muscle tissue at cuts, which is specific for each of the game species.

Fresh upland game carcasses have glossy, dry, and non-smelly beaks; the mucous coat of the mouth is glossy, light pink, and a little wet; the eyes are bulging and completely cover the eye pits; the surface of the carcass is clean, the skin sticks closely to the meat, it is of greyish-yellow hue. The surface of the muscle tissue is a little wet, not sticky. Feathers hold well in the skin; the subcutaneous and visceral fats are white or a little yellowish. The serous tunic of the thoracoabdominal cavity is wet and glossy and does not have any slime or mold. The muscle tissue in cuts is a little wet, has a firm texture, smells of fresh (game) meat. The stock is clear and smells well. The muscles of the wood grouse and black grouse are dark-red, while the partridge and hazel grouse have light-pink meat. The fat from the wood or black grouse is light-yellow, while that from the partridge or the hazel grouse is just light-colored.

The dubious freshness carcasses featured specific changes: the beaks went pale, the mucous coating of the mouth was pale and greyish-pink with a little slime or mold, and emitted slightly stale smell. The eyeballs sank a little, and the cornea lost the gloss. The skin was greyish-yellow, dry. The visceral fat had slight off-odor. The muscle tissue was not firm enough. It became darker in the cuts, and it was wet, slightly sticky. Its smell was sourish-stale. The stock was not so clear and it had a bad smell.

Stale carcasses had clear signs of decay. The beaks were pale and soft. The eyeballs sank completely and they were not glossy. The carcasses were covered in slime, sticky, with specks of mold. The mucous coating of the mouths emitted a bad smell. The signs of decay were especially prominent in the thoracoabdominal cavity: it had a pungent off odor and it was sticky. The serous coating was grey, the muscles limp, and more intensive in color as compared to the fresh carcasses. The small was rotten, and the stock was flaking and had a pungent bad smell [2,5,7,11,13,19].

The stale carcasses of the upland game were obliterated.

We used upland game meat samples of various freshness harvested in the Republic of Sakha (Yakutia) at various times throughout the year. We determined the following parameters: amino-ammonia nitrogen, peroxidase reaction, the amounts of volatile fatty acids, the products of primary protein breakdown, as well as the fat acidity and peroxide values (Table 1).

The results of the physical and chemical parameters of the wood grouse, black grouse, partridge, and hazel grouse meat harvested in the Republic of Sakha (Yakutia) at various times throughout the year can be found in (Table 1).

The data in Table 1 show the sharp changes in the amino-ammonia nitrogen content from 0.78±0.01 mg per 10 ml of extract for fresh meat to 1.8±0.05 for stale meat.

The peroxidase reaction of the upland game meat was positive, which is confirmed by the literature and does not reflect the real freshness due to a large number of injuries from the gunshot. The stale carcasses feature the increase in the amounts of volatile fatty acids from 2.30 ±0.03 to 6.0±1.54 mg/KOH.

The primary protein breakdown test showed that the fresh meat produced clear stock without flakes, the dubious meat produced turbid stock, and the stale meat was flaking profusely.

The typical changes were observed during the fat acidity value test: it increased from 0.8±0.01 to 3.9±0.01 mg/KOH, and the fat peroxide value increased from 0.01±0.01 to 0.74±0.5% J. The pH value varied from 5.99±1.79 for fresh meat to 7.70±0.01 for stale upland game meat.

The microbiological tests were performed for the following parameters: QMA&OAMO, coliform bacteria, including salmonella and Listeriamonocytoqenes [3,4,6,8,9,12,14,15,20]. The results are shown in Table 2.
### Table 1. Physical and chemical freshness indicators for upland game meat and fat.

| No | Indicators                                      | Wood grouse     | Partridge      | Black grouse  | Hazel grouse  |
|----|-----------------------------------------------|-----------------|----------------|---------------|---------------|
|    |                                              | Fresh carcasses | Carcasses of dubious freshness | Stale carcasses |               |
|    |                                              | Amino-ammonia   | Amino-ammonia  | Amino-ammonia |                |
| 1  | Nitrogen (mg/10 ml of extract)                | 0.87 ± 0.01*    | 0.78 ± 0.01*   | 0.91 ± 0.01*  | 0.89 ± 0.01*  |
| 2  | Peroxidase reaction                           | positive        | positive       | positive      | positive      |
| 3  | Amount of volatile fatty acids (mg/KOH)       | 2.30 ± 0.03*    | 2.46 ± 0.05*   | 2.31 ± 0.05*  | 2.49 ± 0.03*  |
| 4  | Primary protein breakdown product test         | negative        | negative       | negative      | negative      |
| 5  | Fat acidity value (mg/KOH)                    | 0.8 ± 0.01*     | 1.2 ± 0.01*    | 1.0 ± 0.05*   | 0.9 ± 0.03*   |
| 6  | Fat peroxide value, % J                       | 0.022 ± 0.01*   | 0.01 ± 0.01*   | 0.03 ± 0.01*  | 0.02 ± 0.01*  |
| 7  | pH                                           | 5.99 ± 1.79*    | 6.20 ± 1.54*   | 6.40 ± 1.53*  | 6.20 ± 1.54*  |

**Carcasses of dubious freshness**

| No | Indicators                                      | Wood grouse     | Partridge      | Black grouse  | Hazel grouse  |
|----|-----------------------------------------------|-----------------|----------------|---------------|---------------|
|    |                                              | Amino-ammonia   | Amino-ammonia  | Amino-ammonia |                |
| 1  | Nitrogen (mg/10 ml of extract)                | 1.45 ± 0.01     | 1.37 ± 0.02    | 1.59 ± 0.01   | 1.35 ± 0.01   |
| 2  | Peroxidase reaction                           | negative        | negative       | negative      | negative      |
| 3  | Amount of volatile fatty acids (mg/KOH)       | 5.2 ± 1.79      | 4.6 ± 1.78     | 4.2 ± 1.54    | 3.8 ± 1.54    |
| 4  | Primary protein breakdown product test         | Insignificant turbidity | Turbidity | Turbidity | Turbidity   |
| 5  | Fat acidity value (mg/KOH)                    | 3.6 ± 1.21      | 3.31 ± 1.21*   | 3.55 ± 1.31   | 3.68 ± 1.39*  |
| 6  | Fat peroxide value, % J                       | 0.57 ± 0.01     | 0.59 ± 0.01    | 0.58 ± 0.01   | 0.61 ± 0.01   |
| 7  | pH                                           | 6.66 ± 2.01     | 6.59 ± 1.87    | 6.70 ± 1.87   | 6.30 ± 1.35   |

**Stale carcasses**

| No | Indicators                                      | Wood grouse     | Partridge      | Black grouse  | Hazel grouse  |
|----|-----------------------------------------------|-----------------|----------------|---------------|---------------|
|    |                                              | Amino-ammonia   | Amino-ammonia  | Amino-ammonia |                |
| 1  | Nitrogen (mg/10 ml of extract)                | 1.8 ± 0.05*     | 1.68 ± 0.05*   | 1.55 ± 0.03*  | 1.63 ± 0.03*  |
| 2  | Peroxidase reaction                           | negative        | negative       | negative      | negative      |
| 3  | Amount of volatile fatty acids (mg/KOH)       | 5.6 ± 1.79*     | 4.9 ± 1.79*    | 6.0 ± 1.54*   | 4.8 ± 1.53*   |
| 4  | Primary protein breakdown product test         | flaking         | prolific       | prolific flaking | flaking |
| 5  | Fat acidity value (mg/KOH)                    | 3.9 ± 0.01*     | 3.2 ± 0.01     | 3.8 ± 0.01*   | 2.73 ± 0.01   |
| 6  | Fat peroxide value, % J                       | 0.68 ± 0.5*     | 0.74 ± 0.5*    | 0.71 ± 0.3*   | 0.65 ± 0.1*   |
| 7  | pH                                           | 7.33 ± 0.01*    | 7.70 ± 0.01*   | 7.01 ± 0.01*  | 6.99 ± 0.02*  |

Note: *P≤0.001
Table 2. The microbiological research of the upland game meat.

| No. | Indicators                                         | Regulatory document | Regulatory document limit value | Actual values Sample 1 | Actual values Sample 2 |
|-----|---------------------------------------------------|---------------------|--------------------------------|------------------------|------------------------|
| 1   | QMA&OAMO                                          | GOST 10444.15-94    | CFU/g up to 1x10^6              | 9·10^2                 | 4·10^2                 |
| 2   | Coliform bacteria                                 | GOST 31747 - 2012   | 0.001 g unacceptable            | Not found              | Not found              |
| 3   | Pathogenic germs, incl. salmonella                | GOST 31659 - 2012   | 25 g unacceptable               | Not found              | Not found              |
| 4   | Listeriamonocytogenes                             | ГОСТ 32031-2012     | 25 g unacceptable               | Not found              | Not found              |

7. Conclusions
During the organoleptic research (appearance, the state of muscular and fat tissues, texture, coloration, boiling tests, etc), the highest rates of the upland game products on the 9-point scale varied within the range of 8.4-9 points, which complies with the regulations on organoleptic parameters of meat products. The amino-ammonia nitrogen content varied from 0.78±0.01 mg per 10 ml of the extract for fresh meat to 1.8±0.05 for stale upland game meat. The stale carcasses feature the increase in the amounts of volatile fatty acids from 2.30 ±0.03 to 6.0±1.54 mg/KOH. The primary protein breakdown test showed that the fresh meat produced clear stock without flakes, the dubious meat produced turbid stock, and the stale meat was flaking profusely. The fat acidity value test showed an increase from 0.8±0.01 to 3.9±0.01 mg/KOH; the fat peroxide value increased from 0.01±0.01 to 0.74±0.5% J. The pH value varied from 5.99±1.79 for fresh meat to 7.70±0.01 for stale upland game meat. 2. During the microbiological tests, coliform bacteria and pathogenic germs, including salmonella and Listeriamonocytogenes were not found in the two samples of meat.

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