Utilization of and research on fungi in Poland

MAKSYM NIKONOROW

Crops of forest fungi in Poland amount to 9,000 tons in years of heavy yield (22). Both fresh and processed fungi are inspected in purchasing centres of the Forest Production Association of Enterprises "LAS" ("Forest") in each processing plant. All these units are also supervised by the health service.

The inspection is performed by specialists specially trained for this purpose. They are responsible for recognition of edible species and evaluation of their quality.

In Poland 49 sanitary-epidemiological stations and 200 field stations operating within the health service system have supervision over foods and their production. The Department of Food Research, National Institute of Hygiene, is the competent body that controls the activities of all the stations and establishes guidelines of their research work and their monitoring investigations.

According to the regulations in force (23) based on the present Polish Food Law issued in 1970 (first act was issued in 1928) 31 species of fungi are accepted for sale and processing. Among them are 15 species of Boletus, two species of honey fungus (Armillaria mellea), tooth fungus (Hydnum) and morel (Morchella), as well as four species of mushroom (Agaricus), edible species of agaric (Lactarius deliciosus), chantarelle (Cantharellus cibarius) and others.

Mixtures of fresh fungi, or of stems with addition of fungi cut into pieces, or mixtures in which the number of stems is higher than the number of caps cannot be accepted for sale or processing. This undoubtedly protects against possible mistakes and failures in detecting toxic species in the mixture, and at the same time it facilitates the recognition of the species which quite often is difficult or even impossible when fungi are divided into parts in the mixture. Fresh fungi are sold loose from the counter or baskets, and dried fungi in transparent packaging or in characteristic strings.

All phases of processing, starting with sorting through packaging, storing and transporting, are supervised by the health service. In 1969-1975, 1,873 samples were examined in one voivodship and one third of them were collected from the production plants (10).


Research on the nutritive value of domestic fungi was initiated by the Department of Food Research in the National Institute of Hygiene. It covered the following species of Fungi: Gyromitra esculenta (Fers.) Fr., Boletus edulis Fr., Cantharellus cibarius...
Table 1. The fungi permitted in Poland for food

| Agaricus bisporus | Macroloba pucerea * |
| A. campestris | Marasmius oreades |
| A. hortensis | Morchella conica |
| A. silatius | M. rotunda |
| Armillariella mellea | Rosites asperata |
| Boletus edulis | Saoporadimbroctum |
| Cantharellus cibirious | Suillus bovinus * |
| Craterellus cornucopioides | S. elegans |
| Gyroporus castaneus | S. flavidus |
| G. cyaneosce | S. granulatus |
| Hydnum repandum | S. luteus * |
| Laetarius deliciosus | S. variegatus * |
| Leucinum aurantiacum | Tricholoma flavivirens * |
| L. rubricatum | Xerocomus badicus |
| L. subrubrum | X. chrysenteron |
| * Also dried and as a meal product |

Fr. and Agaricus bisporus Lange, Tricholoma flavivirens (Fr.) Lund., Armillariella mellea (Fr.) Karst., Macrolobepta procera (Fr.) Sing. and Laetarius velu- reus (Fr.) Fr.In many species the content and digestibility of nitrogenous compounds were determined, taking into account the presence of chitin. This is an insoluble and non-protein compound containing 6.5% of nitrogen. Following the investigations (in vitro and in vivo) another conversion coefficient for nitrogen and protein was suggested. Instead of 6.25 taking into account 16% of nitrogen in the animal protein, this coefficient should be equal to 4.03-4.95 taking Boletus and Helvella as examples (7-9).

It was found that the digestibility of fungal proteins is similar to that of other plant proteins. G. esculenta is a poorer source of protein and nitrogenous compounds than B. edulis, but both show similar digestibility of the nitrogenous compounds (9).

Sclerotera aurantium L. ex Pers. (4, 20) was the subject of chemical investigations, 57 species of fungi belonging to Basidiozymazes family (5) of biological ones, and G. esculenta (14) of toxicological investigations.

Glucose, fructose and mannose were identified in Sclerotera. Sterols were found in its ether extract and indole derivatives in its alcoholic extract. Since similar indole derivatives occur in Psilocybes fungi, this may indicate toxicological significance of S. aurantium. Alanine, arginine, o-amino butyric acid and aspartic acid as well as asparagine, glutamic acid, leucine, serine, tyrosine and valine were also identified (5, 20).

Biological investigations referred to antibacterial activity. Staphylococcus pyogenes var. aureus 209 P and Escherichia coli were test organisms. The strongest inhibition of growth of S. aureus was shown by Marasmius scorodonius (Fr.) Fr. and it has been found to have a most pronounced antibacterial activity (5).

The toxicological investigation of Gyromitra indicated a low acute toxicity of dried fungus for rats and dogs. Fresh fungus administered directly in the form of water brewing and after removal of protein, and also in the form of dried fungi several months after drying, confirmed that the dried fungus may be used for consumption after 6 months' storage (14).

Later investigations of this fungus were made in the Sanitary-Epidemiological Station of the Division of Food and Nutrition in Katowice. The studies were based on observations of toxic symptoms such as irritation of the upper respiratory tract, corestasis and hyperemia of conjunctiva in workers employed in drying the Gyromitra. Investigations on animals in similar conditions revealed changes in the respiratory system, small or extensive extravasation of blood into the pulmonary tissue and haemorrhages into the kidney.

In the distillates and methanol extracts of the fruiting bodies and spores and also in the condensate of the vapour from a drying machine, the presence of the same reducing compounds was found. Among them gyromitrine as well as products of its oxidation or disintegration and methyl formyl hydrazine were identified (1).

In the previous preliminary toxicological studies of Paxillia involutus (Fr.) Fr. it was revealed that boiling in water removes toxic substances only to a certain extent. When extracted in the Soxhlet apparatus they all pass into methanol and slightly less into ethanol. Chloroformic, acetone, benzene and ether (ethyl and petroleum) extracts were not toxic, while the residues after extraction with these solvents caused significant changes in the animals' organs. They were not observed when animals were given the material previously extracted with methanol. In the methanol extract from the fraction of non-protein nitrogenous compounds 12 free amino acids, 8 volatile amines with water vapour including mono-, di- and trimethylamine, guanine, xanthine, hypoxanthine and adenine were identified and histamine, choline, acetycholine, betaine and muscarnine were isolated (12, 13).

Apart from these comprehensive toxicological and chemical studies carried out in the Department of Bromatology, Institute of Environment Studies and Bioanalysis, Pharmaceutical Faculty of the Medical Academy, Lódz, a generous amount of nitrogen, protein, nitrogenous non-protein compounds soluble and insoluble in water (chitin) as well as indispensable amino acids were determined in numerous species of edible fungi. In the majority of cases methionine is a limiting amino acid. This was confirmed by the biological investigations on animals. Only the protein of B. edulis is of biological value.

The carbohydrate content (20-50% of dry matter) and fat fraction (1-8%) were studied. In the phospholipid fraction of Leucinum sordidum (Fr.) S.P. Gray and L. aurantiacum (Fr.) S.P. Gray palmitic and linol
The largest amounts of thiamine, riboflavin and calcium of S. under study (Table 2) may be the source of vitamins. C. ferol were found in the similarities between fungi and fresh vegetables. Four species of fungi in water at 90-95°C caused loss of vitamin in C. cibarius reaching up to 32% and to about 60% in Suillus luteus (Fr.) S.F. Gray (16).

On basis of the vitamin contents determined by other authors in Poland (3) one can find some similarities between fungi and fresh vegetables. Four species under study (Table 2) may be the source of vitamins. The largest amounts of thiamine, riboflavin and calciferol were found in Boletus, and carotene only in C. cibarius.

Data on the identification of amino acids in the protein of S. luteus, A. mellea, Tricholoma georgii and L. velleareus were also obtained in other research centres (24).

The nutritive value, mineral and fat substances as well as amino acid contents were investigated in Hydnum (Sarodon) imbricatum L. ex. Fr. (17). Water and ethanol extracts of this fungus showed mitodepressive and antimitotic activities which are ascribed by the authors to polysaccharides (19).

The microbiological requirements for standardization were suggested on the basis of studies of 14 species of dried fungi and 6 kinds of fungal meal of various compositions. They anticipate the absence of E. coli and poorl y in water, and showing reducing properties. The riboflavin content was compared in several species of fresh fungi and after scalding. Submersion of fungi in water at 90-95°C caused loss of vitamin in C. cibarius reaching up to 32% and to about 60% in Suillus luteus (Fr.) S.F. Gray (16).

On basis of the vitamin contents determined by other authors in Poland (3) one can find some similarities between fungi and fresh vegetables. Four species under study (Table 2) may be the source of vitamins. The largest amounts of thiamine, riboflavin and calciferol were found in Boletus, and carotene only in C. cibarius.

Data on the identification of amino acids in the protein of S. luteus, A. mellea, Tricholoma georgii and L. velleareus were also obtained in other research centres (24).

The nutritive value, mineral and fat substances as well as amino acid contents were investigated in Hydnum (Sarodon) imbricatum L. ex. Fr. (17). Water and ethanol extracts of this fungus showed mitodepressive and antimitotic activities which are ascribed by the authors to polysaccharides (19).

The microbiological requirements for standardization were suggested on the basis of studies of 14 species of dried fungi and 6 kinds of fungal meal of various compositions. They anticipate the absence of E. coli in 0.001 anaerobic sporogenic bacteria and mould (neither mycelium nor hyphae) (2).

Concluding this brief review of studies carried out in Poland, I wish to draw attention to papers on fungus poisonings caused by mistaking toxic for edible fungi (6, 21) and to remind of the probably already known epidemiological and chemical studies of Grzymala carried out over 20 years ago. The role of Grzymala in the development of this branch of science in Poland is undoubtedly quite significant. The studies were related to poisoning with Cortinarius orellanus syn. Agaricus calliseus, Dermocybe orellana. It grows in the period from mid-August to mid-November in coniferous and mixed forests, usually at the border of Poznań and Bydgoszcz voivodships (6). The fungus is not high (5-9 cm) and has a cap of cinnamon and foxy colour, diameter 5-8 cm, with a hummock at the top. Its gills are wide and loose and slightly lighter in colour.

Toxication with this fungus is characterized by a long incubation period of 3 to 14 days and by the following symptoms: intense thirst, and dryness and a burning sensation in the oral cavity. The patient usually drinks over ten litres of liquids per day. Symptoms develop gradually. They are disturbances in the alimentary tract, nausea and vomiting, constipation, headaches, convulsions, loss of consciousness. Death due to toxuria may occur after several weeks. Recovery may take several months.

This fungus produces a thermostable substance readily soluble in the alkali, quite easily in methanol and poorly in water, and showing reducing properties. Grzymala obtained it in the amount of 1.0-1.2 g out of 100 g of dried fungus with a capacity of about 40%. One fruiting body contains about 15-20 mg of this substance. The lethal dose (LD50) for cats is 4.9 mg/kg, for mice and guinea pigs about 8 mg/kg. The substance does not haemolyze and agglutinate blood cells and it probably cumulates in the organism. It was named orellamine.

During the recent National Meeting of Mycologists in Łódź in September 1977 four basic trends of studies in Poland were presented: chemistry and toxicology, processing, cultivation of highly selected species, and ecology. It is quite obvious that the health aspect dominates in these studies, as is also expressed by the research work in the field of laboratory diagnosis of fungus poisoning. These studies are usually carried on by the Sanitary-Epidemiological Station in Poznań.

Table 2. Mean contents of thiamine, riboflavin, ergocalciferol and carotene in 100 g of fresh edible fungi prepared as a dish

<table>
<thead>
<tr>
<th>Kind of fungus</th>
<th>Thiamine</th>
<th>Riboflavin</th>
<th>Ergocalciferol I.U.</th>
<th>Carotenesides</th>
<th>Carotene</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cantharellus cibarius</td>
<td>34</td>
<td>125</td>
<td>89.2</td>
<td>713</td>
<td>448</td>
</tr>
<tr>
<td>range</td>
<td>22-51</td>
<td>43-226</td>
<td>60-100</td>
<td>642-748</td>
<td>410-477</td>
</tr>
<tr>
<td>Boletus edulis</td>
<td>275.6</td>
<td>993</td>
<td>120.7</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>range</td>
<td>197-525</td>
<td>592-1564</td>
<td>100-150</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Tricholoma</td>
<td>57.5</td>
<td>157.7</td>
<td>31</td>
<td>26.4</td>
<td>-</td>
</tr>
<tr>
<td>Plumbeovirens</td>
<td>57-102</td>
<td>70-253</td>
<td>25-40</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Lactarius scabrum</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>range</td>
<td>-</td>
<td>-</td>
<td>100-125</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
co-operating with the Institute of Environment Studies and Bioanalysis and with the Institute of Occupational Medicine in Łódź. Recent analyses and observations confirmed, however, the periodicity of poisoning intensification at several years intervals, but these periods do not always correspond with the years of high fungus crop. It has also been observed that greater numbers of fungus species are being picked by people for consumption purposes. This seems to prove increased knowledge of edible species of fungi. Unfortunately this is not followed by a reduction in cases of poisoning. They are related mainly to confusing Amanita phalloides with wild mushrooms and also to insufficient caution on the part of fungus pickers. It also happens that various edible species are not picked at all in certain regions of the country.  

It is quite obvious that education in this field, begun in childhood, through publications, coloured atlases and exhibitions organized by sanitary-epidemiological stations as well as collective mushroom picking organized by institutions play a very important part in the promotion of principles of how to differentiate toxic and edible species and how to pick fungi properly. This is also related to the protection of the natural environment - a problem of increasing significance year by year.

It may be assumed that the research work initiated by the National Institute of Hygiene and continued mainly by the Department of Bromatology, Institute of Environment Studies and Bioanalysis, Łódź, and also by the Sanitary-Epidemiological Station in Poznań will now develop in the Academy of Agriculture in Poznań, Medical Academy in Kraków and Department of Experimental Studies of "LAS" Enterprise. This enterprise plays a very important part in supplying the home market with forest fungi and in fungus processing and export. It also pays much attention to research work in this field and participates in all related activities (11).

References

23. Rozporządzenie Ministra z dnia 10 stycznia 1959r. w sprawie nadzoru sanitarnego nad obrotem grzybami i przetworstwem grzybów (Dz. U. nr. 5, poz. 34).