Karstenia 18(suppl.) 1978

On the thiamine content of some edible mushrooms

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MÄKINEN, S. M., KURKELA, R. & PARIKKA, T. 1978: On the thiamine content of some edible mushrooms. - Karstenia 18 (suppl.).

The thiamine content of fresh wild mushrooms varied between 1160 µg/100 g dry matter (*Lactarius necator*) and 430 µg/100 g d.m. (*Tricholoma portentosum*) the caps containing more than the stipes. The thiamine content increased during storage of fresh mushrooms in the refrigerator in polyethylene bags. For example, storage for one week at 4° C doubled the thiamine content of fresh *Agaricus bisporus*, while two weeks storage increased it threefold; both increases being statistically highly significant ($P < 0.001$). The thiamine content of *Pleurotus ostreatus* stored at 4° C also increased significantly; that of *Cantharellus cibarius* stored at 4° C and at 10° C for three months, however, increased more at 10° C than at 4° C.

The thiamine content of frozen mushrooms was highest in *Gyromitra esculenta* (1350 µg/100 g d.m.) and nearly as much was found in *Leccinum vulpinum*. The thiamine content decreased after two months storage in the freezer, the decrease being highly significant ($P < 0.001$).

The content of thiamine in freeze-dried and drum-dried mushrooms was on the average lower than in the fresh ones.

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Introduction

In the literature the vitamin content of mushrooms varies much according to study, species, habitat, etc., the results concerning even the same vitamin being rather contradictory (Block et al. 1953, Bötticher 1968, Litchfield 1964, Mlodecki et al. 1973 a, b, c). According to Karosiene (1973, 1974) the thiamine content of fresh *Boletus* varies from 1.55 mg to 11.7 mg per 100 g and that of dried *B. scaber* is 0.89 mg/100 g. Generally speaking, mushrooms are not held to be any excellent sources of vitamins, although they may be significant in some special conditions, for example in vegetarian diets.

Since there did not exist any investigations concerning the vitamin content of Finnish edible fungi, analyses were started by determining the thiamine content of some wild and cultivated Finnish mushrooms in the summer of 1976.

Materials and methods

Mushrooms

Fresh: *Flammulina velutipes* and *Pleurotus ostreatus* were cultivated by Dr. Roponen at the Biochemical Research Institute, Helsinki. Fresh *Agaricus bisporus* were obtained from two Finnish commercial cultivators. *Albatrellus ovinus, Cantharellus cibarius, Cortinarius armillatus, Lactarius necator, Naematoloma capnoides* and *Tricholoma portentosum* were picked from forests in 1976.

All fresh mushrooms were stored in polyethylene bags at 4° C.

Frozen: *Boletus edulis, C. cibarius, Gyromitra esculenta, Lactarius rufus, L. torminosus, L. trivialis* and *Leccinum vulpinum* were obtained from Valio Finnish Co-operative Dairies' Association. They were from the crop of 1976 and were stored in polyethylene bags at -20° C.

Dried: Freeze-dried *A. ovinus, Cortinarius armillatus, C. triumphans, Hydnum rufescens, Lactarius necator, L. torminosus,* and *N. capnoides* were obtained from the Department of Botany, University of Helsinki, and *F. velutipes* from the Department of Botany, University of Turku. Powdered drum-dried *L. rufus* and *L. trivialis* were prepared at the Department of Food Chemistry and Technology, University of Helsinki.

All dried mushrooms were stored in polyethylene bags at room temperature.

The thiamine content of mushrooms was determined by the fluorometric method of AOAC (1970). The yield was 94±1.9% when a known amount of thiamine was added to a homogenized mushroom preparation.

Results and discussion

The thiamine content of fresh wild mushrooms varied between 1160 µg/100 g d.m. in *L. necator* and 430 µg/100 g d.m. in *T. portentosum* (Table 1). The caps contained more thiamine than the stipes (Table 2), as has been reported also by Karosiene (1973, 1974) for *Boletus*.

Table 1. Thiamine content of fresh mushrooms stored at 4° C (mean ± SEM or ranges)

Mushroom	Thiamine µg/100 g d.m.	Time of storage days
Lactarius necator	1160±80	16
Albatrellus ovinus	950±60	7
Cortinarius armillatus	870	2
Flammulina velutipes	820-850	2-3
Naematoloma capnoides	480±40	15
Cantharellus cibarius	440-480	7-96
Tricholoma portentosum	430	10
Pleurotus ostreatus	490-840	1-9
Agaricus bisporus	390-1030	1-16

Table 2. Thiamine content in the caps and stipes of fresh and frozen mushrooms (mean ± SEM)

Mushroom	Thiamine µg/100 g d.m.		Time of storage
	Caps	Stipes	
Fresh			days at 4° C
Agaricus bisporus	730±40	330	8
Naematoloma capnoides	480±40	80	15
Tricholoma portentosum	430	80	10
Agaricus bisporus	400±30	200	1
Frozen			months at -20°C
Gyromitra esculenta	1350±80	450	4.5
Leccinum vulpinum	1260±70	790	2.5
Boletus edulis	1020±50	850	3
Lactarius trivialis	860±20	550	2.5
L. rufus	800±30	270	3
A. bisporus	500±30	330	3

An astonishing result was that the thiamine content of fresh mushrooms increased during storage in refrigerator in polyethylene bags. For example, storing for one week at 4° C doubled the content of fresh *Agaricus*, while two weeks storage increased it threefold (Fig. 1), both increases being statistically highly significant ($P<0.001$). The thiamine content of *P. ostreatus* stored at 4° C also increased significantly (Fig. 1). *C. cibarius* was stored at 4° C and at 10° C for 3 months. The thiamine content increased in both stores, more at 10° C than at 4° C (Fig. 2).

The thiamine content of frozen mushrooms was highest in *G. esculenta*, 1350 µg/100 g d.m., and nearly as much was found in *L. vulpinum* (Table 3). The content usually decreased when storing at freezer, which is seen in Fig. 3. The decrease in thiamine in false morels stored in freezer for 2 months was highly significant ($P<0.001$). A highly significant decrease could be seen also in *L. torminosus* and a significant decrease ($P<0.01$) in *L. trivialis*, while a highly significant increase was detected in *B. edulis* and a significant increase ($P<0.01$) in *A. bisporus*. The thiamine content of *C. cibarius* stored in freezer for 4.5 months remained nearly constant (Fig. 3).

Fig. 1. Content of thiamine in two lots of fresh *Agaricus bisporus* and *Pleurotus ostreatus* during storage at 4° C. Mean ± SEM are indicated.

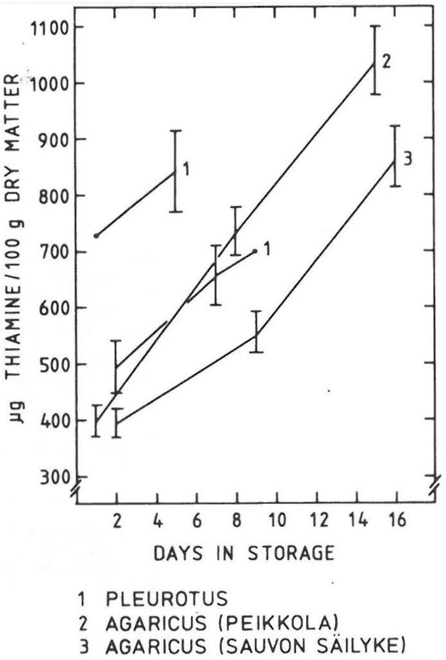


Fig. 2. Content of thiamine in fresh *Cantharellus cibarius* during storage at 4° C and at 10° C. Mean ± SEM are indicated.

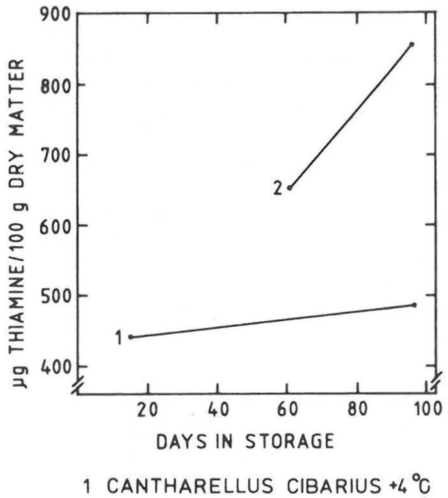
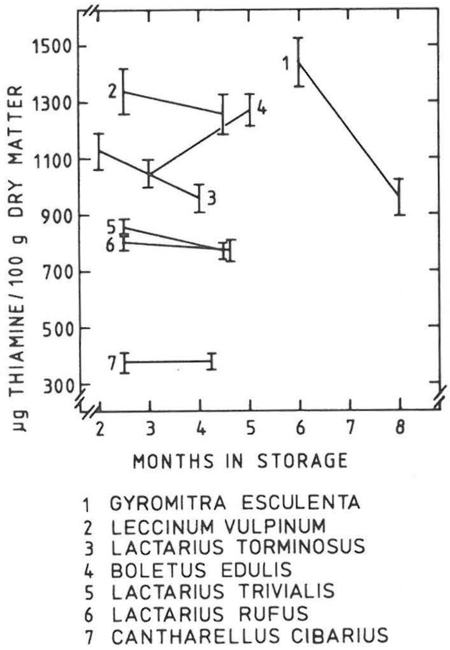


Table 3. Thiamine content of frozen mushrooms (mean ± SEM)

Mushroom	Thiamine µg/100 g d.m.	Time of storage months at -20° C
Gyromitra esculenta	1350±80	6
Leccinum vulpinum	1340±75	2.5
Lactarius torminosus	1110±60	2
Boletus edulis	1020±50	3
Lactarius trivialis	860±20	2.5
L. rufus	800±30	2.5
Agaricus bisporus	525±30	3
Cantharellus cibarius	375±30	2.5

Fig. 3. Content of thiamine in frozen mushrooms during storage at -20° C. Mean ± SEM are indicated.



The content of thiamine in freeze-dried and drum-dried mushrooms was on the average lower than in the fresh ones, from 30 to 70 per cent of the amount found in fresh mushrooms (Table 4). Straight conclusions of the effects of freezing on the thiamine content of fresh mushrooms cannot be made on the basis of these experiments, because frozen mushrooms were not from the same place as the fresh ones. The gradual decrease in thiamine when mushrooms are stored in freezer may be due to cell breathing, which occurs although slowly, even at freezer temperature.

It is indeed a fact that the thiamine content may increase during storage at refrigerator temperature, which rarely occurs to any vitamin in foodstuffs

Table 4. Thiamine content of freeze-dried and drum-dried mushrooms

Mushroom	Thiamine µg/100 g d.m.
Freeze-dried:	
Lactarius necator	1310
Albatrellus ovinus	1030
Lactarius torminosus	980
Cortinarius armillatus	610
Flammulina velutipes	550
Cortinarius triumphans	370
Naematoloma capnoides	150
Hydnum rufescens	120
Drum-dried:	
Lactarius rufus	670
L. trivialis	640

generally. Karosiene (1973, 1974) has reported that old *Boletus* contain less thiamine than the young ones due to dropping of spores, which are rich in thiamine. Some kind of ripening may explain the increase of thiamine in fresh mushrooms stored in refrigerator and of *Agaricus* and *Boletus* in freezer. However, the dependence of changes in thiamine content on the oxygen and carbon dioxide pressure in the package should be studied.

On the basis of these results, mushrooms are a fairly good source of thiamine, the content corresponding to that found in pork, peanuts and rye bread. Before evaluating the real nutritional value of edible fungi, however, the losses occurring in food preparation should also be investigated.

Acknowledgement

This study has been financed by a grant from the Academy of Finland, for which the authors owe their gratitude.

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