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Juice concentrates of edible mushrooms

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Mushroom juice concentrates are refined products, attractive to consumers for their high organoleptic value to be used as an additive to different products and dishes and in the preparation of soups and sauces.

In this investigation *Tricholoma equestre, Cantharellus cibarius, Russula alutacea* and *Armillariella mellea,* growing in Polish forests were used for concentrate production. The juice of fresh, frozen or dried fungi was obtained by pressing or extraction, concentrated by vacuum distillation or freezing and stored at 4° C.

The quality of the juice and of one- and two-component concentrates was determined chemically and organoleptically. Freezing of mushrooms before the juicing step was found to be benefical in chemical and organoleptic evaluation. Concentration by cryoscopic technique allows the juice to retain the original specific taste characteristics. The concentrates of *Xerocomus badius* and *T. equestre* as well as the combined concentrates containing *Xerocomus* juice were found to be of high sensory value.

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Materials and methods

Fruit-bodies of *Armillariella mellea* (Fr.) Karst., *Cantharellus cibarius* Fr., *Russula alutacea* (Fr.) Fr., *Tricholoma equestre* (L. ex Fr.) Quél, and *Xerocomus badius* (Fr.) Kühn, were collected from pine woods in western Poland (Poznań and Miedzychód regions) in the autumns of 1973-1977 in 5-40 kg sample lots each. According to Polish Norm $\frac{\text{PN-76}}{\text{R-78505}}$ the mushrooms were of the first quality class.

Dry weight (at 105° C), soluble solids (by refractometer), titrable and volatile acids (as acetic acid), esters (as ethyl acetate) and Kjeldahl-N were measured by standard methods. Protein N (with chitin) and NH_2-N were determined according to Bielozierski (1954). For sensory evaluation the five-unit organoleptic method of Tilgner (1957) was used.

The mushroom juice was obtained in a manual basket press (5 kg capacity) and a pilot plant layer press (Bücher-Guyer AG, TPZ-7, 25-30 kg capacity) after milling of the fresh or frozen fruit-bodies in Rietz disintegrator. *T. equestre* was classified according to the scheme for combined processing (Sobkowska & Woźniak 1978) and the broken fruit-bodies were used. The juice was sterilized at 120° C for 22 minutes or was directly concentrated.

The juice of *X. badius* was obtained by extraction of fruit-bodies dried, after slicing, in air blast dryer at 50-60° C during 12 h (for 10 kg samples) to 6% water content. Extraction of crushed material was performed in laboratory extractor Quickfit, at 50° C (temperature according to Zurakowski 1964). The extraction efficiency was 500 ml of extract from 500 g of dry material.

Concentration was performed by vacuum distillation and by freezing technique described below. After pasteurization at 100° C during 30 minutes the concentrates were stored at 4° C.

Results and discussion

All the studied fungi with lamellar hymenophore (*T. equestre, C. cibarius, R. alutacea,* and *A. mellea*) were well adapted for juice pressing. The yield depended on the kind of press (basket or layer press) as well as on the state of the mushrooms (fresh or frozen). The highest yield (67-75%) was obtained from frozen fruit-bodies pressed after disintegration and thawing on the layer press (Table 1). In this process the balance, shown in Table 2, makes about 75% of juice,about 20% of marc and about 5% losses, in comparison with 60%, 35% and 5%, respectively from fresh fungi of second quality (broken).

About 35% of the total dry weight of raw material was recovered in juice from frozen fungi, as compared with 26% recovery from fresh mushrooms (Table 3). The respective recovery values for acid and ester, which are compounds influencing the taste, were 50-60% for frozen and 40% for fresh fungi.

The distribution of the nitrogen fraction, i.e. compounds representing the nutritive value of product, between juice and marc is shown in Table 4. Generally, with 60% yield of juice the marc retained about 70% of total N (together with chitin) and only about 60%

Table 1. Yield of juice obtained from *Tricholoma equestre* using basket press and layer press.

Sample	Basket press %	Layer press %
Mushrooms, fresh	50-60	60-67
Mushrooms, frozen	60-65	67-75

Table 2. Yield of juice obtained from fresh and frozen *Tricholoma equestre* using Bücher-Guyer press

Sample	Juice %	Marc %	Losses %
Mushrooms,			
Broken ϕ >6 cm	57.5	36.5	6.0
	63.6	31.5	4.9
	57.4	36.3	6.3
on av.	59.5	34.7	5.7
Fresh ϕ 1.5-4.5 cm	63.5	31.5	5.0
	67.5	30.3	2.2
	65.5	34.5	0.0
on av.	65.5	32.1	3.6
Frozen ϕ 1.5-4.5 cm	77.2	18.3	4.5
	72.2	23.3	4.5
	74.3	20.5	5.2
	74.5	20.7	4.8

Table 3. Distribution of some components between juice and marc of *Tricholoma equestre*, *Cantharellus cibarius* and *Xerocomus badius*.

Mushroom	State	Juice yield %	Content in juice			
			Dry weight % of tot.	Esters % of tot.	Acids: Titrable % of tot.	Acids: Volatile % of tot.
T. equestre	Fresh	59.0	26.0	38.7	41.3	38.3
	Frozen	74.0	34.5	51.4	56.7	50.5
C. cibarius	Fresh	56.0	26.5	40.6	38.0	40.3
	Frozen	70.0	35.0	57.2	60.9	49.8
X. badius	Dried-extracted	-	47.4	65.9	64.5	62.1

Table 4. Distribution of nitrogen fractions between juice and marc of *Tricholoma equestre*. Juice yield 60%.

Product	Sample	Cold storage months	Recovery: Total N %	Recovery: Protein N %	Recovery: NH_2-N %
	Mushrooms,				
Juice	Fresh	-	26.8	28.9	33.3
	Frozen	0	29.0	31.3	36.1
		6	29.1	24.9	40.7
Marc	Fresh	-	67.8	70.6	62.8
	Frozen	0	65.3	68.8	59.0
		6	64.7	73.9	47.0

of NH_2-N. This is reflected in the contribution of amine-N in the total nitrogen of pulp, juice and marc from fresh and frozen mushrooms (Table 5). In pulp the ratio of NH_2-N to total N is about 70%. In juice this increases to 86% from fresh and 95% from frozen fungi, and drops in marc to about 50%.

The obtaining of juice from mushrooms with porous hymenophore (*Xerocomus* and *Suillus*) is more complicated. The pressing method was not effective for either fresh, frozen or dried mushrooms. Juice of a high organoleptic value could be obtained, however,by the extraction method, using as a raw material dried, crushed *X. badius*.

Several technological procedures were investigated for juice concentration using vacuum distillation and freezing techniques. In the former, juice was concentrated in a laboratory rotary glass evaporator, Unipan 319 B (vapor temperature 25° C) 7-10 strength concentrate; in Quickfit extractor (bottom part) used as evaporator (concentration temperature 90° C); in Titano laboratory evaporator (conc. temp. 60° C) 4 strength concentrate in the upper part and 12 strength in the bottom; Alfa-Laval Centritherm (conc. temp. 40° C) 10 strength concentrate. The de-aromatization technique was used, and after storing the juice was reconstituted for organoleptic evaluation. All concentrates yielded juice of high organoleptic value. Unfortunately, the direct comparison of juices obtained from the different evaporators is not yet available owing to the small individual lots of raw material.

The freezing technique was also used but to a lesser extent and only for *T. equestre* juice, the ice being separated by centrifugation or decantation. The juice concentrates (7 strength) obtained by this method differed greatly from juice obtained by the thermal method. When vacuum distillation was used the taste and flavour characteristics of the concentrated juice and soups obtained were in general typical of mushrooms and close to the dried mushroom taste, the colour also being brown. In the freezing method the concentrates retained the green colour typical of the juice of this fungus and the very specific aroma of *Tricholoma*.

Table 5. Nitrogen fractions in pulp, juice and marc of *Tricholoma equestre*.

Sample	Product	Cold storage months	Total N g/100 g d.w.	NH_2-N g/100 g d.w.	NH_2-N % of total N
Mushrooms,					
Fresh	pulp	-	3.47	2.41	69.5
Frozen		6	3.35	2.40	70.9
Fresh	juice	-	3.51	3.03	86.3
Frozen		6	2.99	2.73	95.0
Fresh	marc	-	3.56	1.93	54.1
Frozen		6	4.82	2.51	52.0

The soups obtained from both kinds of concentrate also differed greatly and needed separate qualification cards for organoleptic evaluation, both being of high organoleptic value (mean scores 4.0-4.5 units on the five-unit scale).

In Table 6 are listed the comparative organoleptic scores on the five-unit scale of the concentrated juices obtained from the different mushrooms by the same method of evaporation, and in Table 7 the influence of storage for 4 months at 4° C on the sensory evaluation. The juice from *X. badius* was the best, followed by *T. equestre* and *C. cibarius* juices. The concentrate of *R. alutacea* was organoleptically unattractive; amelioration was achieved by mixing it with *X. badius* juice, which, in general, was the best material for raising the sensory value of juice concentrates of poor quality. The favourable effect of mixing different mushrooms in concentrate production has been reported earlier by Bötticher (1941, 1950), the only investigator who has worked on wild mushroom processing problems on a larger scale.

Table 6. Organoleptic scores of mushroom juice concentrates.

Concentration temperature 25° C
Laboratory evaporator Unipan 319 B
Final extract content 30%
Pasteurization 30 min at 100° C
Storage 4° C

Sample	One-component concentrate	Two-component concentrate: *T. equestre* 1:1	Two-component concentrate: *X. badius* 1:1
Tricholoma equestre	4.3	-	4.4
Xerocomus badius	4.7	4.4	-
Cantharellus cibarius	4.1	4.1	4.3
Russula alutacea	2.9	-	3.8
Armillariella mellea	3.8	3.0	4.0

As was stated above, frozen mushrooms release juice with a higher efficiency than fresh ones (Tables 1 and 2), the extraction of valuable components also being better (Table 3, 4 and 5). As shown in Table 7, the favourable effect of freezing was reflected also in the sensory evaluation of concentrate from *T. equestre* as compared with concentrate from fresh fungi. This supports the proposal of the combined processing method for *T. equestre* (Sobkowska & Woźniak 1978).

In Table 8 the chemical composition of concentrated as against single strength mushroom juices is given. After pasteurization at 100° C for 30 minutes the concentrates were stable chemically and organoleptically during the investigated four months of storage at 4° C.

Table 7. Effect of storage (4 months, +4° C) on the organoleptic values of mushroom juice concentrates and obtained soups

Sample	Storage time months	Concentrate from mushrooms: Fresh	Concentrate from mushrooms: Frozen	Concentrate from mushrooms: Dried	Soup from concentrate: Fresh	Soup from concentrate: Frozen	Soup from concentrate: Dried
Tricholoma equestre	0	4.1	4.3	-	4.0	4.3	-
	4	4.0	4.3	-	3.9	4.1	-
Cantherallus cibarius	0	4.1	4.1	-	4.1	4.2	-
	4	4.0	4.0	-	4.0	4.0	-
Xerocomus badius	0	-	-	4.9	-	-	4.8
	4	-	-	4.9	-	-	4.8
T. equestre } 1:1 *C. cibarius*	0	4.1	-	-	4.2	-	-
	4	4.1	-	-	4.2	-	-
X. badius } 1:1 *C. cibarius*	0	-	-	4.3	-	-	4.4
	4	-	-	4.5	-	-	4.5

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Table 8. Effect of storage at 4° C on the chemical and organoleptic evaluation of mushroom juice concentrates.

Sample		Storage time months	Content in 100 g of sample			Mean organoleptic score	
			Extract (ref.) g	Titrable acidity ml 0.1 n NaOH	Esters mg ethyl acetate	Sample	Soup
Tricholoma equestre,							
	fresh		4.0	27	255	4.8	-
	juice		3.3	19	158	-	-
	concentrate	0	29.0	133	1 216	4.1	4.0
		4	29.1	134	1 184	4.0	3.9
	frozen		3.2	20	239	4.5	-
	juice		3.2	19	166	-	-
	concentrate	0	30.0	140	1 348	4.3	4.3
		4	30.0	140	1 340	4.3	4.1
Cantharellus cibarius,							
	fresh		4.0	22	402	4.2	-
	juice		3.4	16	288	-	-
	concentrate	0	30.0	101	1 985	4.0	4.0
		4	30.2	105	1 933	4.0	3.9
	frozen		3.4	19	355	4.1	-
	juice		3.4	17	290	-	-
	concentrate	0	30.0	98	2 105	4.1	4.2
		4	30.1	102	2 088	4.0	4.0
Xerocomus badius,							
	fresh		5.5	22	343	5.0	-
	juice		4.0	12	192	-	-
	concentrate	0	30.5	91	1 386	4.9	4.8
		4	30.5	92	1 378	4.9	4.8