THE CHEMICAL CONTENT AND FEEDING VALUE OF ENRICHED WITH CHROMIUM, SELENIUM AND ZINC YEAST *SACCHAROMYCES CEREVISIAE*[*]

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Abstract

Dietary dry yeasts (*Saccharomyces cerevisiae*) enriched with Se, Cr and Zn were studied for the content of crude protein, ash, fiber, fat and N-free extractions, metabolizable energy and amino acids, as well as many minerals content in the fresh mass. We observed high content of nutrients (protein - 35,9-40,5%, energy - about 25 MJ/ kg). The concentration of bioelements was average: Se – 1534, Zn – 8717,3 i Cr – 891,1 ppm. Enrichment in macro- and microelements was described as the availability (apparent absorption), which was determined for Cr, Se and Zn for laying hens and young fatteners with the use of the balance method.

INTRODUCTION

Dietary yeasts are used in feeding of monogastric animals and ruminants as the valuable source of protein (amino acids) and energy, as well as vitamins (B group) and bioelements (Stone 1998).

A variety of dietary yeast strains are produced worldwide. These are dry bakery, brewery and whey yeasts etc. The following species are the most frequently used: *Saccharomyces cerevisiae, Torulopsis utilis* and *Kluyveromyces marxianus (Reed and Nagodawidhana 1991)*.

The aim of the present paper was to assess the chemical content of yeasts *Saccharomyces cerevisiae* with incorporated bioelements towards applicability in feeding of monogastric animals and livestock.

MATERIALS AND METHODS

Bakery yeasts (*Saccharomyces cerevisiae*) were incubated in the laboratory and pilot-plant-scale, in the presence of salts of Cr, Se and Zn according to the method described by *Ryszka et al. (2002*). The proposed method of yeasts production was characterized with the lack (or low amount) of liquid and solid wastes, and high biomass yields.

Biological material obtained with this method underwent chemical analysis. The analysis of the basic content (dry matter - DM, crude protein - CP, crude ash - CA, crude fat - CF, N-free extractions, metabolizable energy – ME) was carried out with the use of standard methods, according to AOAC (1990). Amino acids (AA) content were determined in amino aids Analyzer Carlo Erba type. The content of macro- and microelements, including selenium, zinc and chromium

Project granted by Polish Committee for Scientific Research No 7T 09 B 111 20

in the yeast biomass was determined by ICP (Inductively Coupled Plasma) method with microwave digestion (*Górecka, 1995*). Also, availability of Cr, Se and Zn in the case of laying hens (ISA BROWN) and young pigs (Polish breed) was assessed with the balance method *(Jamroz, 2002)*.

The results were studied statistically with the use of Statgraphics v. 5.0 package.

RESULTS AND DISCUSSION

The chemical composition of 3 kinds of yeasts *Saccharomyces cerevisiae* (Y-Se, Y-Zn, Y-Cr) are shown in Table. 1. Y-Zn had the highest content of CA, CP and CF, though, the lowest content of NFE ($p<0.05$) when compared to Y-Se yeasts. The chemical composition of Y-Cr was similar to Y-Zn. The obtained experimental results showed that nutritive value of yeasts enriched in bioelements, and the content of CA, CP, CF, AA and ME were comparable to ordinary and brewery yeasts. The analysis of amino acids content (Table 2) showed the highest concentrations for glutamic and aspartic acid and lysine, the lowest was for methionine, cysteine and tryptophan. The highest content of amino acids was present in Y-Cr (290.38 g/kg), and the lowest Y-Se (271.05 g/kg). The largest statistical differences between the studied kinds of yeasts were in the case of proline, cystine and phenylalanine ($p<0.05$).

As a result of the process of yeasts enrichment, the average selenium content in Y-Se was 1534 ppm, up to 1728 ppm, zinc 8717.3 ppm, and chromium 891.1 ppm. These concentrations depended on incubation conditions (carbohydrates concentrations, yeasts content, time and incubation temperature, salts concentration) (*Ryszka et al. 2002*). These yeasts composition was normalized with the standards of animals feeding (Ca, P, Mg, Na, Fe, Mn, Co) and were enriched with trace elements (Table 3), which biological role is not fully understood yet (*Kabata-Pendias and Pendias 1999*). The content of metals considered to be toxic (As, Cd, Hg, Pb), regulated by EC Directive (1999), was not exceeded, though (Table 4).

The results of balance studies in animals showed a good bioavailability of selenium, chromium and zinc from yeasts, when introduced to feed mixtures. In the case of young pigs, apparent absorption of these elements was for Se 80.2, for Cr 43.4 and Zn 28.6%, when introduced in the amounts respectively, 0.2, 1.0 and 80 mg/kg of standard feed. In the case of laying hens, apparent absorption for these elements was lower: for Se 45.0, for Cr 28.1 and for Zn 32.4 % when introduced in the form of yeasts as the feed additive in the amount 1.0, 1.0 and 50 mg/kg, respectively.

The amino acid content was slightly different in the studied yeasts, particularly in the case of exogenous amino acids, predominantly containing sulfur (*Smulikowska 1993*). It is necessary to indicate high content of Zn, Se and Cr, which could substitute these additives in dietary pre-mix (*Dobrzański and Opaliński 2002*).

Concluding, it is necessary to state out, that dietary yeasts enriched with chromium, selenium and zinc might be a good source of protein and many bioelements, used in feeding of monogastric animals in the form of feed components or used in the production of mineral-vitamin pre-mixes.

REFERENCES

AOAC.1990. Official Methods of Analysis. Edition 15 (ed: K. Helrich) Association Of Official Analytical Chemists Arlington WA, USA

Górecka H. 1995. Wykorzystanie spektrometrii plazmowej w badaniach ekotoksykologicznych. Ekol. Tech., 2, 11-14.

Jamroz D. 2001. Żywienie zwierząt i paszoznawstwo, Wyd. Nauk. PWN Warszawa.

Kabata-Pendias A., Pendias H. 1999. Biogeochemia pierwiastków śladowych, Wyd. Nauk. PWN Warszawa.

Reed G., Nagodawidhana T. W. 1991. Yeast technology, Van Nostrad Rinhold, New York.
Ryszka F., Dobrzański Z. Dolińska B. 2002. Optimization of the process of selenium, chromium and zinc incorporation into yeasts Saccharomyces cerevisiae. In: Chemical products in agriculture and environment. Ed. by H. Górecki and Z. Dobrzański, Czech-Pol Trade, Praque Brussels Stockholm, vol. 3, 234-239.
Stone C.W. 1998. Yeast products in the feed industry. cstone@diamonddw.com. Diamond V. Mills. Inc. Cedar. Rapids, Iowa USA.

Table 1. *The chemical content of yeasts (Y) enriched with selenium, zinc, chromium (n=5)*

Yeast	YCr	YSe	YZn
Component (%)			
Dry matter	95,19	96,34	95,76
Crude ash	5,04b	4,67b	6,13a
Crude protein	39,71a	35,89b	40,51a
Crude fiber	trace	trace	trace
Crude fat	1,12	0,94b	1,21a
NFE	49,32b	54,84a	47,91b
Metabolizable Energy			
Kcal/kg	6010,6	6033,1	5970,2
MJ/kg	25,14	25,24	24,98
Bioelement (ppm)			
Se	4,23	1534,0	0,52
Zn	265,3	263,4	8717,3
Cr	891,1	2,13	3,00

a-b: $p<0,05$ (Bioelements no comparison between groups)

Table 2. *Amino acid content of yeasts (Y) enriched with selenium, zinc, chromium (g/kg) (n=5)*

Amino acid	YCr	YSe	YZn
Asp	31,89a	28,02b	30,44
Thr	15,39	14,38	15,69
Ser	16,67	16,21	16,19
Glu	36,30	42,15	36,87
Pro	10,69a	5,35b	9,67a
Cys	3,34b	6,39a	3,44b
Gly	13,11	11,76	12,40
Ala	18,93	17,20	18,24
Val	14,48	13,33	14,98
Met	3,99	3,67	4,03
Iso	12,07	10,65	12,35
Leu	24,71a	21,93b	24,19
Tyr	6,50	8,32	6,35
Phe	27,80b	16,84a	22,47b
His	8,26	7,89	8,45
Lys	26,94	25,94	22,31
Arg	13,02	15,39a	12,18b
Try	6,29	5,63	6,57

a-b: $p<0,05$

Table 3. *Elements content of enriched yeast (Y) in chromium, selenium and zinc (ppm)*

Element	Content		
	YCr	**YSe**	**YZn**
Phosphorus (P)	10930	7650	11240
Magnesium (Mg)	1780	1190	920
Calcium (Ca)	620	1120	1130
Natrium (Na)	9730	540	1690
Iron (Fe)	200,4	170,3	191,5
Aluminium (Al)	13,29	12,2	12,65
Manganes (Mn)	11,06	9,79	12,44
Copper (Cu)	3,87	6,15	3,45
Strontium (Sr)	6,14	4,34	7,07
Silver (Ag)	< 0,002	2,65	0,151
Palladium (Pd)	< 0,003	3,81	0,044
Nickel (Ni)	0,600	2,32	< 0,05
Scandium (Sc)	1,56	1,86	1,45
Vanadium (V)	< 0,002	1,27	1,46
Cobalt (Co)	0,601	0,598	0,885
Platinum (Pt)	0,079	0,577	< 0,003
Tellurium (Te)	< 0,07	0,381	< 0,07
Titanium (Ti)	0,365	0,379	2,46
Ytrum (Y)	0,248	0,345	0,238
Gold (Au)	< 0,003	0,216	0,108
Gallium (Ga)	< 0,004	0,197	0,148
Barium (Ba)	0,371	0,192	4,04
Osmium (Os)	< 0,004	0,137	< 0,004
Beryllium (Be)	0,058	0,121	< 0,005
Cesium (Cs)	0,120	0,080	0,080
Rhodium (Rh)	< 0,001	0,078	< 0,001
Indium (In)	0,070	0,047	0,038
Niobium (Nb)	0,009	0,028	0,010
Thallium (Tl)	0,070	0,024	0,145
Cerium (Ce)	< 0,0006	0,019	0,113
Bismuth (Bi)	1,93	0,019	0,551
Lanthanium (La)	0,019	0,010	0,089
Uranium (U)	0,016	0,009	0,060
Thorium (Th)	0,173	< 0,001	0,114
Germanium (Ge)	0,037	< 0,01	0,077

Table 4. *Toxic metals content in yeast (Y) of chromium, selenium and zinc (ppm)*

Element	**(YCr)**	**(YSe)**	**(YZn)**
Arsenic (As)	5,94	4,25	2,95
Cadmium (Cd)	< 0,002	0,125	< 0,002
Lead (Pb)	1,39	0,078	3,98
Mercury (Hg)	< 0,07	0,15	< 0,07