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EFFECT OF NUCLEIC ACID REMOVAL TECHNIQUES ON AMINO ACID COMPOSITION OF YEAST PROTEINS

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Abstract

Nine different techniques for reduction of nucleic acid (NA) content in yeast homogenate were used and their effect on amino acid (AA) composition were evaluated. These techniques can be catagorized in either protein of NA precipitation and enzymatic hydrolysis of NA. Profile of AA composition of proteins remained when NA were hydrolysed by endogenous ribonuclease and when NA were precipitated by phase separation was much different from other techniques. Essential AA concentrations usually improved when NA were reduced. The change in AA composition will change quality and properties of that protein system.

Introduction

Utilization of single cell protein (SCP) as a food has been considered by authorities concerned with world food supplies and population increase. With the problem of increasing population, there is no doubt that much larger supplies of protein will be needed in the future. Even with improved agricultural technology, the problem of supplying adequate food is not readily achieved. Some industrialized countries such as the Soviet Union and Japan and those in Western Europe depend on the world market for much of their food supply. In 1972, bad weather and drought proved that even North America, which is the major supplier of food to the world, is vulnerable to shortages [10].

Energy, land and labor are major factors in determining the economic feasibility of providing foods. The production of animal protein requires tremendous amounts of energy, land and labor.

Yeasts one of the SCP groups has widely been used as a source of protein for man and animals. It has several advantages: a high protein content; very rapid mass growing time; and can be grown on waste materials such as molasses [7].

There are some limitations in using yeasts as food: (a) The tough yeast wall resists digestion and the whole cell may pass through the digestive tract intact [13]. Disruption of the cell wall is therefore important to enable release and recovery of interacellular proteins. (b) Yeasts and most SCP have higher nucleic acids (NA) contents than conventional foods, probably because of their higher growth rate. After ingestion, the NA are depolymerized by pancreatic nucleases to nucleotide. Purines are not metabolized further than uric acid in man and higher primates because of the lack of the enzyme uricase. Therefore, they appear in urine as uric acid rather than being converted to the more soluble compound «allantion». Some individuals have a tendency for the over production of uric acid which may lead to the precipitation of uric acid in joints of soft tissues and the formation of kindney stones in the urinary tract [4].

Therefore lowering NA in yeast has been considered and their effect on protein has been evaluated.

Key words: Yeast proteins, Amino acid composition, Nucleic acid.

Material and Methods

A commercial press baker's yeast cake (**S. Cerevisiae**) was washed with 0.1 M tris buffer pH 8.5. The cells were broken by agitation with glass beads in a Brownwill homogenizer which was cooled with a current of CO_2. After removal of cell walls and the unbroken cells by centrifugation at 2000xg, the NA

Table 1: Amino acid composition of yeast proteins lowered in nucleic acids by different treatments (g amino acid / 100g corrected protein).

Amino Acid	Control	Protamine Sulfate[1]	Protamine Sulfate[2]	Phase Separation	Streptomycin	$MnCl_2$	NaCl	pH Adjustment	Exogenous RNase	Heat Shock	Bakers Yeast Protein*
Aspartic Acid	12.80	11.72	12.72	10.21	11.99	12.64	12.74	12.86	13.60	12.30	11.41
Threonine	5.01	4.68	4.92	6.47	5.31	5.62	5.59	5.56	5.15	5.66	5.03
Serine	4.76	5.91	4.69	7.56	4.91	5.36	5.28	5.48	6.40	5.43	4.93
Glutamic Acid	10.05	13.03	11.56	11.03	10.89	12.26	11.81	12.64	12.31	12.85	11.52
Proline	3.47	2.93	3.38	3.65	3.29	3.61	3.64	4.44	3.42	4.54	4.32
Glycine	3.95	4.01	3.92	4.92	3.15	4.35	4.44	5.01	4.11	4.06	4.48
Alanine	5.57	5.60	5.76	7.17	6.55	6.40	6.45	6.63	5.41	5.56	6.16
Valine	5.95	6.22	6.18	6.82	6.51	6.49	7.27	6.51	6.14	6.30	5.85
Methionine	1.24	1.50	1.30	1.13	1.64	1.69	1.82	0.98	0.97	1.01	1.92
Cysteine[3]											1.10
Isoleucine	5.00	5.09	5.18	5.33	5.04	5.53	5.10	4.56	4.81	4.60	5.59
Leucine	7.95*	8.18	8.04	8.39	9.20	8.87	8.16	7.21	6.92	6.81	8.88
Tryosine	4.52	4.09	4.53	2.69	4.64	3.30	5.00	3.41	4.06	4.15	4.45
Phenylalamine	5.86	6.17	5.78	6.63	7.04	6.76	6.18	6.67	7.95	7.46	5.58
Histidine	2.38	2.47	2.48	2.41	2.58	2.56	2.66	1.97	2.26	1.93	2.86
Lysine	9.43	9.29	9.56	7.45	9.40	10.74	9.5	10.52	9.02	8.14	9.45
Arginine	8.24	5.26	4.36	4.47	3.74	4.92	5.29	4.21	4.12	3.48	5.91
Tryptophan[3]											1.69

* From McCormick, R. D., 1973, Food Product Development, 7:6, 17.
[1]Protamine sulfate treated and proteinase inhibitor (PMSF) added.
[2]Protamine sulfate treated no proteinase inhibitor added.
[3]Was not measured.

were reduced by (a) precipitation of NA with protamine sulfate [5], streptomycin [3], manganous chloride [8], and / or phase separation [1]. (b) Separation of proteins from NA by precipitation of proteins with pH adjustment [6] or hot sodium chloride [7]. (c) Hydrolysis of NA by activation of endogenous ribonuclease (RNase) in a heat - shock [12] or using bovine RNase [2].

Amino acid analysis of yeast proteins was performed on a Beckman / Spinco 121 - C automatic amino acid analyser [11], employing 24 hours acid hydrolysis.

Results and Discussion

The data in Table 1 illustrates the amino acid (AA) composition of yeast cell homogenate before and after reducing the nucleic acid content. Generally, valine, phenylalanine and methionine (all essential AA) concentrations were improved when NA were reduced. Isoleucine and leucine were present at increased levels in the protein remaining after NA precipitation and in NaCl method, but decreased in other separated proteins.

In general, the AA composition in heat - shock and phase - separated proteins was much different from the others. Essential AA concentrations usually improved when NA were reduced. In NA precipitation techniques, it was expected to see a decrease in aspartic acid and glutamic acid concentrations in the remaining proteins, but this did not occur. Since during acid hydrolysis of proteins aspargine and glutamine have a tendency to lose their amido group [14] and form aspartic acid and glutamic acid, the values for these latter two AA are partly from aspargine and glutamine.

Variation in AA composition is a result of the behavior of different proteins toward the different techniques used to reduce the NA content. For example, some proteins are more susceptible to proteolysis. Therefore, in these methods that protein-

ases have more chance for activation the susceptible proteins would be in lower concentrations and result in the change in AA composition pattern. The change in AA composition will change quality and properties of that proteins system.

Nutritionally, yeast proteins have a good proportion of AA except for sulfur AA (methionine and cysteine). Lysine in yeast protein is higher than most of cereal proteins and yeast protein is therefore an ideal supplement to flour. The other essential AA in the yeast protein are comparable to animal or oil seed proteins [9].

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