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Nutritional Quality of Protein in Mushrooms(คุณภาพโภชนาการของโปรตีนในเห็ด)

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ORIGINAL ARTICLE

คุณภาพโภชนาการของโปรตีนในเห็ด

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บทคัดย่อ

ได้ทำการประเมินคุณภาพของโปรตีนของเห็ดเพาะเลี้ยงชนิดรับประทานได้พันธุ์ต่าง ๆ เห็ดสด ประกอบด้วย โปรตีนประมาณ 3 % และมีความชื้นอยู่ประมาณ 90 % ส่วนประกอบของกรดอมิโนของโปรตีนของเห็ดได้แสดงไว้ให้เห็นด้วย เห็ดมีส่วนประกอบทั้งหมดของกรดอมิโนทั้งจำเป็นและไม่จำเป็น คะแนนกรดอมิโนแสดงให้เห็นว่าโปรตีนของเห็ดบางพันธุ์มี วาลีน ลูซีน และไอโซลูซีนจำนวนจำกัด อย่างไรก็ดี ลัยซีนมีจำนวนจำกัดอยู่บ้าง เห็ดทุกพันธุ์มีกรดอมิโนที่มีซัลเฟอร์ในจำนวนไม่เพียงพอ เห็ดดูเหมือนจะเป็นแหล่งที่ดีของทริพโตเฟน เฟนนิลอลานีน และทัยโรซีน

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Nutritional Quality of Protein in Mushrooms

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ABSTRACT

The protein quality of different species of cultivated edible mushroom was evaluated. Fresh mushrooms contained about 3% of protein and about 90% of moisture. Amino acid composition patterns of mushroom protein were demonstrated. Mushrooms constituted all of the essential and the nonessential amino acids. The amino acid scores indicated that the protein of some species of mushroom was limiting in valine, leucine and isoleucine, however, lysine was partially limiting. All species of mushroom contained an insufficient quantity of sulfur containing amino acids. Mushrooms seemed to be a good source of tryptophan, phenylalanine and tyrosine.

INTRODUCTION

Mushrooms are commonly eaten by humans because it is a more palatable plant. It can be cultivated productively even in a limited area. Mushrooms seem to contribute a high protein content which might be a good source of protein for poor people who could not afford an expensive animal protein or for the vegetarian who does not eat meat. Protein is the most essential component contributing to the nutritional value of food. Fat and carbohydrate are rarely lacking in diet, therefore,

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they are not generally considered in nutritional evaluation. Protien intake is generally low in developing countries. In Thailand about 50% of pre-school children are suffer from protein malnutrition especially in the northeastern part of Thailand. The main cause of the insufficiently intake of animal protein is due to economic reasons. The price of animal products has increased so high that poor people could not afford to buy them. They rather sell them instead of use them as their diet. People in Thailand commonly consume rice almost every meal. Rice is not a good source of protein since it contains an insufficient quantity of some essential amino acids such as valine tryptophan, methionine and especially lysine and threonine (1, 2). Therefore, it is important to find other good sources of protien in order to use them as protein supplements. Protein sources from plant food are important since they contribute amino acid that are important and should be feed simultaneously with small amount of a complete protein food. An alternative way to receieve enough complete protein is by providing a correct mixture of several plant foods which will give all of the amino acids in approximate amounts for those who do not eat meat. The amino acid profile is important in evaluating the nutritive quality of protein. This report presents a primary result of nutritive quality of protein in mushrooms commonly eaten in Thailand. Amino acid composition of mushrooms was studied and amino acid scoring pattern was determined.

MATERIALS AND METHODS

Chemicals Ninhydrin, absolute ethanol, trisodium citrate, 2-methoxy ethanol, sodium acetate, potassium sulfate, silinous acid, all chemicals of analytical reagent purity were obtained from E. Merch Darmstadt, Germany. Ammonium sulfate was supplied by Mallinkrodt Chemical works. Boric acid was obtained from Biedel-De Hean, Hannover. All other chemicals of analytical reagent purity were supplied by E. Merck Darmstadt. Germany.

Protein Sources Mushroom samples of fresh *Volvariella volvaceae* and *Pleurotus sajor-caju* were supplied by the Section of Applied Microbiology, Department of Agriculture. Dried *Lentinus edodes* was bought from the local market. Canned *Agaricus bisporus* was obtained from Tongkok Heatee Manufactory, Bangkok.

Moisture and Protein Determination Mushroom samples were cut into thin small pieces and dried in the hot air oven at 100°c until constant weight was obtained and then the moisture content was calculated (3). Ground samples were analyzed for nitrogen by Macro-Kjeldahl procedure described in AOAC (4). A Kjeldahl factor of 6.25 was used in converting nitrogen (N) content to % of protein for each species of mushroom studied.

Amino Acid Analysis Amino acid composition was determined from ground dried samples by using Hitachi Perkin Elmer Amino Acid Analyzer after hydrolysing

with 6 N HCl for amino acids and with performic acid and 6 N HCl for cystine (5). Tryptophan was assayed colorimetrically with dimethylaminobenzaldehyde after hydrolysing with barium hydroxide as described by Matheson (6).

The amino acid or chemical scores of various amino acid were calculated from the amino acid composition (7). The equation for the calculation shown below :

$$\text{Amino acid scores} = \frac{\text{mg. of an amino acid in 1 g. test protein}}{\text{mg. of that amino acid in 1 g. reference protein}} \times 100$$

RESULTS AND DISCUSSION

The protein content of mushrooms was found to be rather high among vegetable sources (1). It was found that crude protein of mushrooms in fresh and canned samples existed about 3% and dried shiitake constituted 20.19% protein. The protein and the moisture contents of mushrooms studied are shown in table 1. The data present the average values from two or three experiments. Fresh shiitake was found to compose of 73.63% moisture. One can approximate the protein content of fresh shiitake to be about 6%. However, the quantity of protein in fresh mushrooms seemed to present lower quantity than protein in some legumes (1,2). Protein that contain all essential amino acids in sufficient quantity and in the right ratio to maintain nitrogen equilibrium and to permit growth are complete protein, these proteins are the protein in egg, milk, meat, poultry and fish. Most of plant protein such as legumes and grains are classified as incomplete protein since these proteins do not supply all the essential amino acids in appropriate amounts to maintain nitrogen equilibrium and growth. Thus grain and legume proteins give only fair or low biological value (2). Nutritional values of dietary protein depend primarily on the concentration data of their constituent amino acids. The amino acid composition pattern is one of the most important data in evaluating the nutritive quality of various protein sources. The amino acid composition of mushrooms studied in our laboratory is shown in Table 2. The mushroom samples contained all of the essential amino acids as well as most commonly occuring nonessential amino acids. The essential amino acids exist within a range of 42–49% to the total amino acid content. This result was in agreement to the other studies previously reported (8). The amino acid composition patterns of various mushrooms were difference. In order to consider the completeness of mushroom protein, a comparision of the essential amino acids in mushroom to the amino acid reference pattern is illustrated in Table 3. The distribution of the essential amino acids in egg and human milk has been recommended by the joint committee of FAO/WHO for use as the ideal reference pattern. However, in 1973 a new provisional amino acid scoring pattern was devised based on additional data on amino acid requirement (7). The amino acid

Table 1 Moisture and protein content of edible mushrooms

Scientific Name	Common Name	Sample	Crude Protein (%) (N × 6.25)	Moisture (%)
Volvariella volvaceae	Chinese or Straw mushroom	Fresh	3.16	90.74
Agaricus bisporus	Botton mushroom or champignons	Canned	3.47	89.73
Pleurotus sajor-caju	Angel mushroom	Fresh	3.77	90.27
Lentinus edodes	Shiitake	Dried	20.19	11.87

Table 2 Amino acid content of mushrooms in 100 grams of edible portion

Amino Acid	*Volvariella volvaceae* (Fresh)	*Agaricus bisporus* (Canned)	*Pleurotus sajor-caju* (Fresh)	*Lentinus edodes* (Dried)
Tryptophan (mg)	48	67	40	197
Threonine (mg)	117	217	94	816
Isoleucine (mg)	116	197	90	574
Leucine (mg)	134	288	143	962
Lysine (mg)	112	304	176	938
Methionine (mg)	14	44	65	188
Cystine (mg)	19	28	32	190
Phenylalanine (mg)	253	539	291	1,848
Tyrosine (mg)	65	95	69	302
Valine (mg)	126	212	118	654
Arginine (mg)	99	235	79	817
Histidine (mg)	60	124	93	682
Alanine (mg)	139	183	143	683
Aspartic acid (mg)	180	319	136	1,179
Glutamic acid (mg)	417	502	385	2,269
Glycine (mg)	74	140	91	534
Proline (mg)	108	174	73	550
Serine (mg)	94	167	69	660

Table 3 Comparison of mushroom protein to FAO/WHO standard amino acid pattern

Amino Acid	FAO/WHO 1973 Provisional amino acid scoring pattern mg/g. of protein	*Volvariella volvaceae* (mg/g. protein)	*Agaricus bisporus* (mg/g. protein)	*Pleurotus sajor-caju* (mg/g. protein)	*Lentinus edodes* (mg/g. protein)
Isoleucine	40	34.6	49.3	26.5	32.8
Leucine	70	40.0	72.0	42.1	55.0
Lysine	55	33.4	76.0	51.8	53.6
Methionine + Cystine	35	9.9	18.0	28.5	21.6
Phenylalanine + Tyrosine	60	94.9	158.5	105.9	122.9
Threonine	40	34.9	54.3	27.6	46.6
Tryptophan	10	14.3	16.8	11.8	11.3
Valine	50	37.6	53	34.7	37.4

scores of mushroom protein are illustrated in Table 4. Amino acid for which a protein has a score lower than 100 is the limiting amino acid. The chemical score for the protein was determined from the amino acid for which a protein has the lowest score. The chemical scores of *Volvariella volvaceae*, *Agaricus bisporus* *Pleurotus sajor-caju* and *Lentinus edodes* was found to be 28, 51, 60 and 61, respectively. Sulfur containing amino acids were limiting in mushroom. The other limited amino acids in mushrooms, except in *Agaricus bisporus*, were leucine, isoleucine and valine. *Agaricus bisporus* seemed to be a partially incomplete protein. It should be noted here that this sample was the finished product in can. The differences in amino acid content may consider according to the fact that the mushroom harvested from different composts (9).

Table 4 Amino acid scores of essential amino acid of mushrooms

Amino Acid	Amino Acid Score FAO/WHO			
	Volvariella volvaceae	*Agaricus bisporus*	*Pleurotus sajor-caju*	*Lentinus edodes*
Isoleucine	86.5	123.3	66.3	82.0
Leucine	57.1	102.9	60.1	78.6
Lysine	60.7	138.2	94.2	97.5
Methionine+Cystine	28.3	51.4	81.4	61.7
Phenylalanine+ Tyrosine	158.2	264.2	176.5	204.8
Threonine	87.3	135.8	69.0	116.5
Tryptophan	143.0	168.0	118.0	113.0
Valine	75.2	106.0	69.4	74.8

Studies on crude mushroom protein, some researchers suggest that only 60–80% of the protein (N × 6.25) is digestible (10, 11). This may be explained by the fact that mushrooms contain a significant quantity of non protein nitrogen in their chitinous cell wall. One suggests the correction factor to calculate crude protein using factor equal to (70% N × 6.25) or (N × 4.38). This correct crude protein factor, however, may not be accurate for all species of mushroom and it is not represent

the true protein content. It was suggested that 100–200 g. of mushroom (dry weight) required to maintain nutritional balance in normal human weighing 70 kg. This quantity of mushroom containing about 30–60 g. of protein which will be sufficient since normal adults require 0.8–1 g. of protein/kg. body wt./day (12). A proper combination of mushroom with some other vegetables or of different species of mushroom for regular diet is recommended. For those who can have animal protein a small amount of animal protein should be added in order to have a sufficient quantity of protein to maintain nitrogen equilibrium and to permit normal growth. Vegetables and plant products that partially lack of the essential amino acids such as bean sprouts, bean curds, green peas, may be added to vegetable meal. This combination is, however, lacking in methionine.

CONCLUSION

Mushrooms seem to be a good source of plant protein. The results from our laboratory showed that mushroom protein should be classified as partially imcomplete protein. It contained rather low amount of sulfur containing amino acids, methionine and cystine. The combination of few species of mushroom should be prepared for diet in order to have a proper amino acid balance. *Pleurotus sajor-caju* had deficiencies in isoleucine and leucine but contained partially high methionine, may be mixed with *Agaricus bisporus* which contained enough isoleucine and leucine but rather low in methionine. Other sources of vegetable protein such as bean sprouts, bean curds may be used in combination as well. However, these proteins have insufficient sulfur containing amino acids. Synthetic methionine can be added to the meal for those who do not eat animal proteins. Amino acid score of a protein is, however, a crude way to evaluate the quality of protein. The digestibility of the protein and the availability of the amino acids both in vitro and in animal assay are understudy in our laboratory to gain insight into the biological value of protein in mushrooms.

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