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The Nutrient Composition of *Podaxis pistillaris*

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ABSTRACT. Fruiting bodies of the edible mushroom *Podaxis pistillaris*, growing in the wild in various regions of Saudi Arabia, were collected to determine their nutritive value for human consumption. The main chemical constituents determined were moisture content (76%), total nitrogen (5.0%), total crude protein (N × 6.25) averaged (22-37%), true protein (34,9%) total carbohydrates (18.5%), total lipids (2.3%), and ash content (12.4%). The quantities of desirable (K, Na, Fe, Mg, Mn, Ca and Zn) and undesirable minerals (Pb and Cd) were determined. Seventeen amino acids were also determined. These constituents are discussed in terms of the importance of *P. pistillaris* as a source of nutrients for human consumption.

Podaxis is a genus of edible mushrooms which grow in sand and sandy loam soil in areas with long dry spells, between 40°N and 40°S latitude (Morse 1933). The genus was reported by Morse (1933) to be monotypic with a single species, *Podaxis pistillaris* (L.: Pers.) Fr. However, the genus has been divided recently into more than one species (McKnight 1985). The fruiting bodies appear after rains, generally in the spring and early summer (Khan & Khan 1979). The fruiting body of *P. pistillaris* has a tall erect stalk and a dry head 6-10 cm long and 10-15 mm thick. In the early stages of development, the head is smooth, but later it is covered with large ragged scales (Miller 1972).

In Saudi Arabia, large quantities of *P. pistillaris* are collected from vast plains and deserts by nomads during the rainy season. The fruiting bodies are used as food either alone or in combination with other foods as a source of flavour. Nutritionally, mushrooms are generally highly regarded and are often referred to as «vegetable beef steak». Ramasamy & Kandaswamy (1978) have reported that *P. pistillaris* is rich in proteins containing all the dietary essential amino acids. However, research to evaluate the nutritional characteristics of this mushroom has

not been intensively carried out.

The present study was undertaken to determine the nutrient composition of *P. pistillaris* growing in Saudi Arabia.

Materials and Methods

The fruiting bodies of *P. pistillaris* growing under natural conditions were collected from the Qaseem, Hail and Jouf regions of Saudi Arabia. Fruiting bodies were kept in polyethylene bags inside an ice chess as a precaution measure to prevent loss of moisture. Afterwards they were dried in an oven at 70°C for 72 hrs and finally grounded to a powder.

For amino acid determination, the fruiting bodies were washed with deonized water to remove surface contaminants, sliced into 5 mm thickness, and freeze-dried. Moisture and ash contents were estimated by the standard methods of analysis using the A.O.A.C. procedure (1965). Total nitrogen and total protein were determined using a Kel-Foss Automatic 16200 instrument (A/S N FOSS ELECTRIC, DENMARK). The true protein content of *P. pistillaris* cells was determined by the Robinson-Hogden-biuret method described by Herbert *et al.* (1971), using a Pye Unicam SP 8-400 UV. VIS spectrophotometer.

Qualitative and quantitative determination of amino acids present in *P. pistillaris* were made using an amino acid analyzer (L.K.B. 4400). Total carbohydrates were determined by the phenol method (Herbert *et al.* 1971), and total lipids determined by extraction of total crude lipids according to the method of Bligh and Dyer (1951). Potassium, sodium, lead, iron, cadmium,magnesium, manganese, calcium and zinc were determined (Chapman & Prat 1961), using a Perkin-Elmer 305 B Atomic Absorption Spectrophotometer. The mean value of each constituent was calculated on a dry-weight basis.

Results and Discussion

The results (Table 1) show that *P. pistillaris* contains approximately 76% moisture. Since *P. pistillaris* has a leathery texture, it is expected to have a lower moisture content compared to other mushrooms; For example *Agaricus bisporus* and certain truffles have an average about 90% moisture content (Abou-Heilah *et al,* 1987, Barbero 1969). Failure to correctly take into consideration the moisture content of fresh or dehydrated mushrooms will lead to distorted estimates of their nutritive value.

The protein content of *P. pistillaris* (Table 2) compares favourably with that of other mushrooms such as *Volvariella diplasia* (Bano *et al.* 1971), and *A. bisporus* (Chang, 1972). The protein content of *P. pistillaris* ranges between 2.3%-26.5%. Ramasamy & Kandaswamy (1978) have reported that the protein contents increases with the increase in the age of sporophore. However, Chang (1972) reported that the protein content of *V. volvacea* decreased with increase in the age of the sporophore. The protein content in *P. pistillaris* (21.81%) is lower than that in *A. bisporus* (38.2%) (Abou-Heilah *et al.* 1987), but is comparable to dried peas (24.2%), beans (24.0%) and corn flour (7.8%) (Flegg & Maw 1976).

Studies on total mushroom protein (N × 62.5), suggest that only 34-89% of the protein is digestible, (Lintzel 1943). Other studies indicate a probable digestibility of 60-70% (Gilbert & Robinson 1957). The reduced digestibility of mushroom protein may be due to the presence of large amounts of nonprotein nitrogen in chitinous cell walls, and thus nitrogen is calculated as total protein by standard nitrogen analysis.

Table 1. Main chemical constituents of fresh fruiting bodies of *P. pistillaris*.

Constituents	**Percent (%)***
Moisture content	76.00
Total nitrogen+	04.98
True protein+	34.90
Total carbohydrates+	18.50
Total lipids+	02.25
Ash content+	12.37

* Values are the mean of three replicates.
\+ Calculated as dry weight basis.

Table 2. Total protein content in fresh fruiting bodies of *P. pistillaris* using different conversion factors

Nitrogen to Protein Conversion Factors	**Percent (%)***
4.38**	21.81
6.25	31.13
8.48	42.23

* Values are the mean of three replicates and calculated as dry weight basis.
** *Podaxis* varies in total protein content from as low as 2.3% to as high as 26.5% (In edible stages averaged 21.81%).

A closer approximation of total protein of mushrooms can be obtained using a conversion factor (70% N × 6.25) or (N × 4.38). Although the use of this conversion factor may not be appropriate to correct total protein content in all species of mushrooms, it is applicable in estimation of total proteins in *P. pistillaris*.

The total proteins calculated as N × 4.38 may show that mushrooms have a high nutritive value but it is a less accurate indicator for "true protein". Using the factor 4.38, it was found that total protein in *P. pistillaris* was 21.81% (Table 2) while true protein which was determined colormetrically averaged 34.90% (Table 1).

The corrected total protein content of mushrooms usually show wide variations even among different samples of a given species. Protein content may vary from as low as 4.9% for species of *Auricularia* to as high as 44% for *Agaricus* (Crisan & Sands 1978). The present analyses indicate a range in protein content of *Podaxis* from as low as 2.3% to as high as 26.5%. In contrast Chang (1972), found little difference in the crude protein content of *Volvariella volvacea* cultivated on different composts.

Using the factor 4.38, our average results for total proteins in mushrooms fell within the range of analysis of the mushroom strains 24-44% reported by Crisan & Sands (1978).

To solve the confusion concerning mushroom protein, Fitzpatrick *et al.* (1946), found that a purified mushroom protein isolate contained 11.79% N rather than the expected 16%. Based on their data, a conversion factor of 8.48 would be more appropriate for estimating mushroom proteins. This factor seems to be accurate based on the present results of total protein and true protein. Since the total N content (4.98%) (Table 1) is far below the presumption of 16% we believe, according to our findings of total N (Table 1), total protein (N × 8.48), (Table 2) and true protein, (Table 1), that a conversion factor of 8.48 is the most accurate factor when compared with 6.25 and 4.38 factors, because total protein should always be higher than true protein as it contains conjugated «true protein» in addition to free protein.

The qualitative analysis of *P. pistillaris* indicated the presence of seventeen amino acids including all the essential amino acids listed by Gopalan *et al.* (1974) (Table 3). Comparison of the amino acid composition of mushroom proteins with other protein sources such as in vegetables, showed that mushroom proteins are usually relatively high in lysine (5.4%) which is comparable to the lysine in *Pleurotus cystidiosus* (Misra *et al.*, 1983). Mushrooms can be used in human diet to supplement the limiting lysine in cereal and vegetable proteins.

The method described by Bligh & Dyer (1951) was used to determine the crude lipids in *P. pistillaris*. The lipid content of mushrooms on dry weight basis was found to be 2.25% in (Table 1).

Fresh *A. bisporus* contains relatively large amounts of carbohydrates (3-28%) and ash (8-23%) (Crisan & Sands, 1978). The carbohydrate content may consist of a large variety of compounds. Carbohydrate content of *P. pistillaris* was analysed and found to be 18.5% and ash was 12.37% (Table 1). These percentages fall within the range reported by Crisan & Sands (1978).

Mineral analysis of mushrooms showed that potassium (16.45 ppm) and calcium (11.82 ppm) rank in comparison to other elements (Table 4). In agreement with the findings of Crisan & Sands (1978), trace amounts of iron (0.45 ppm) were found. Manganese (0.03 ppm) was also present in trace amounts. Undesirable minerals such as lead were found to be 0.06 ppm which is well below the range reported by Thomas *et al.* (1972), for *A. bisporus* (0.36 ppm).

Table 3. Amino acid content of fresh fruiting bodies of *P. pistillaris*

Amino Acids	gm/100gm*	% of total amino acids
Alanine	1.630	6.5
Arginine	1.772	7.4
Aspartic acid	3.203	13.2
Cystine	0.272	1.1
Glutamic acid	4.714	19.3
Glycine	1.366	5.7
Histidine	1.199	4.9
Isoleucine	1.339	5.4
Leucine	1.759	7.3
Lysine	1.277	5.4
Methionine	0.168	0.6
Phenylalanine	1.098	4.5
Proline	O.845	3.4
Serine	1.410	5.7
Threonine	1.182	4.8
Tyrosine	0.327	1.3
Valine	0.847	3.4

* Values are the mean of three replicates and calculated as dry weight basis.

Table 4. Analysis of minerals in fresh fruiting bodies of *P. Pistillaris*

Mineral constituents	(ppm) *
Cadmium	Nil
Calcium	11.82
Iron	00.45
Lead	00.06
Magnesium	05.29
Manganese	00.03
Potassium	16.45
Sodium	05.80
Zinc	00.68

* Values are the mean of three replicates and calculated as dry weight basis.

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المكونات الغذائية لفطر بوداكس بيستيلاريس

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قسم النبات ـ كلية العلوم ـ جامعة الملك سعود ـ ص. ب ٢٤٥٥ ـ الرياض ١١٤٥١
المملكة العربية السعودية

تم في هذا البحث تجميع عينات من الأجسام الثمرية لفطر بوداكس بيستيلاريس (العرجون) والذي ينمو طبيعياً في مناطق مختلفة من المملكة العربية السعودية، وذلك لتحليلها كيميائياً والتعرف على قيمتها الغذائية للإستهلاك البشري. وقد اشتملت الدراسة على تحديد المكونات الكيميائية الرئيسية لهذا الفطر ووجدت كالتالي :

محتوى الرطوبة ٧٦ ٪، النيتروجين الكلي ٥ ٪، البروتين الكلي ٢٢ ـ ٣٧ ٪، البروتين الحقيقي ٣٤,٩ ٪، المواد الكربوهيدراتية الكلية ١٨,٥ ٪، المواد الدهنية الكلية ٢,٣ ٪ ومحتوى الرماد ١٢,٤ ٪. كما أن الدراسة شملت أيضاً التحديد الكمي للعناصر المرغوب فيها غذائياً مثل البوتاسيوم، الصوديوم، الحديد، الماغنسيوم، المانجنيز، الكالسيوم والزنك، والعناصر غير المرغوب فيها مثل الرصاص والكاديوم.

وقد تم تعريف وتحديد كمية سبعة عشر حمضاً أمينياً أساسياً، ونوقشت هذه المكونات على ضوء أهميتها كمصدر غذائي للإنسان.