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**Research Article**

# The Analysis for the Nutritional Ingredient of Wild Edible Fungus in Tourist Attraction-taking Yunnan Province as an Example

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**Abstract:** This study is to provide new thinking for the local tourism by understanding of nutritional ingredient in wild edible fungus in tourist attraction, thus the nutrient value and medical value of edible fugus can be converted to economic value preferably. Taking several common wild edible fugus in Yunnan tourist attraction as an example, this paper analyzes the nutritional ingredient such as amino acid, vitamin, inorganic salt, carbohydrate, fat, etc., according to the detection method of food nutrient content. It aims to provide scientific basis for the development and utilization of wild fungus and attract more tourists to drive local economic development at the same time.

**Keywords:** Analysis for nutritional ingredient, standard method, tourism scenic area, wild edible fungi

## INTRODUCTION

Edible fungi is a large type of edible fungus eaten by human beings, *Sparassis crispa*, *Red mushroom* (*Russula virescens*, *Lactarius deliciosus* (Qianru, 2002), *Lactarius volemus*), *Lucid ganoderma*, mushroom, *Volvaria volvacea*, *Agaricus bisporus*, *Hericium erinaceus* and so on. For a long time, edible fungi are credited with function of trophism, nourishing and pharmacodynamics. Edible fungus food integrates features of trophism, functionality, delicacy, security into a unity and it is recommended as one of the top ten health foods by nutritionist. Such material composition of edible fungi could not only make it have good nutrition characteristics, but also enable it to implement good health care function (Limei *et al*., 2013). Modern pharmaceutical research shows that (Chudzyski and Falandysz, 2008) primary health care function of edible fungi includes regulating the balance of human body, enhancing immunoregulation ability of human body, antifatigue, lowering serum cholesterol, blood glucose and blood fat, improving blood circulation, strengthening angiocarpy, reducing blood pressure, preventing and treating cardiovascular and cerebrovascular diseases, guarding against the forming of cancer cell, restraining tumor growth, relieving symptoms of cancer, antiviral, antisepsis and anti-inflammation, it has certain protective effect on liver (Kalac, 2009).

In recent years, rural tourism is new tendency of developing Chinese tourism industry. People's knowledge about the nutrition and health value of wild edible fungus has been enhanced gradually, the development and utilization of wild edible fungus in rural tourism industry is promoted. Yunnan province is a region with numerous and diverse wild fungus species, which is beneficial to develop the tourism resources advantage of village itself and attract tourists. The rural tourism taking advantage of developing and utilizing wild edible fungus resources is the industrial

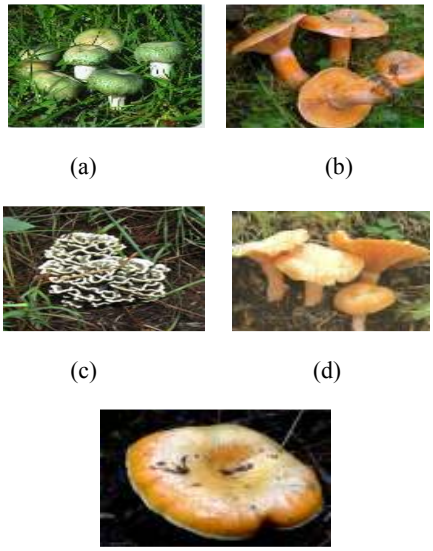


Fig. 1: The graph of several wild edible funguses, (a) *Russula virescens*, (b) *Lactarius deliciosus*, (c) *Thelephora ganbajun* zang, (d) *Lactarius volemus*, (e) *Lactarius hatsudake*

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power source of tourism economy in Yunnan province (Li *et al*., 2011). Through nutrient analysis of the common wild edible fugus, this paper aims to provide basis for scientifically making use of the rich wild edible fugus resource in Yunnan, make tourists to better know the edible fugus, inspire their interests on picking and cook the edible fugus, strengthen the competitiveness of Yunnan tourism and push the development of local economy.

Thus samples of fresh wild fungus should be selected to perform research in tourism scenic spots (Fig. 1).

## MATERIALS AND METHODS

**Material:**

**Fresh samples of wild edible fungi:** They are respectively picked from such tourism scenic spots as Kunming, Dali, Yimen county of Yuxi city, Anning, Chuxiong and so on in Yunnan province, where common and fresh wild edible fungus with large production and high economic value accounts for the largest proportion. Random sampling on that day is performed with corresponding method specified in 'determination method of nutritional ingredient in food' by professional staff, edible part is extracted according to the folk traditional method, weighed and calculated (Hongying, 2013). Then it is washed with distilled water for 3 times after being cleared up with tap water, its moisture would be air dried. A moderate amount of distilled water is added into all the material under test, then it is detected after full blending and beating with high-speed homogenate machine at the speed of 10000 r/min. $V_C$ Must be measured within 24 h, the sample with the other indicators could be preserved after being processed with the corresponding method stipulated in 'determination method of nutritional ingredient in food', the detection would be accomplished within 7 day (Yanping, 2009).

**Cook and process sample:** The traditional cooking and processing samples in folk: fresh wild edible fungus is chopped into slices about 0.2 cm, 1600 *W* electric frying pan is used, a little golden dragon fish oil is added into the pan, oil temperature is about 125°C, stir-fry with emergency fire is made for 2-3 min until it is done, then salt is added into it, a little water could be added into it in the process of frying. The sample of water canned: Fresh green mushroom fungus —> rinse —> blanching —> refrigeration —> overall canning —> adding soaking liquid —> vacuum seal is made through pumping —> autoclave sterilization (121°C×30 min).

**Method:** Analysis is performed according to national standard method:

Moisture-ordinary pressure (105°C) -drying weighing method.

Protein-micro Kjeldahl method (N×6.25); fat-Soxhlet extraction.

DF (Dietary Fiber) -Neutral detergent method; ash content-burning weight method.

Heat energy, carbohydrates-method of calculation.

Inorganic element-ICP-AES method, selenium-determination method of fluorescence spectrophotometry.

Vitamin-Carotene detection is made with paper chromatography, $V_{PP}$ is applied with microbiological method, $V_{B1}$, $V_{B2}$ and $V_C$ is applied with fluorescence method.

Amino acid-Hitachi 835-50 automatic amino acid analyzer is applied for detection after acid hydrolysis, colorimetry is used to detect after tryptophan being alkaline hydrolysis.

Quality control standard-inorganic element uses GBW08551 pig liver powder, the other ingredient uses the standard milk powder provided by Nutrition and food research institute in China Academy of Preventive Medicine.

Two parallel samples are made; the result takes the average value.

**Primary instrument:** Plasma emission spectrograph such as inductive coupling and so on, Hitachi 835-50 automatic amino acid analyzer, 960 Fluorescence spectrophotometer instrument, autoclave.

## RESULT ANALYSIS

**The content of essential nutrient ingredient in wild edible fungus of Yunnan province (Table 1 and 2):** We could know from Table 1 that there exists difference among the essential nutrient of different bacteria, but the difference is not big. The common point that they share is that all these bacteria have relative rich protein and dietary fiber. The protein content of fresh sample is 1.5-26.9%, the content of DF (Dietary Fiber) is 1.5-12.9%, which is higher than many market vegetables, where morel has the highest quantity of protein and dietary fiber. Through making analysis for the nutritional ingredient of several common bacteria, its content of thermal energy and fat is low, nutritional ingredient represents the characteristics of high quality protein, low-calorie and low fat. This is also the value of wild mushroom, which could also attract tourists to go shopping and make sightseeing tour on this scenic spot.

Amino acid is the basic unit of protein composition (Jiang *et al*., 2009) and plays an important role in vital movement of human body. Amino acids can be divided into essential amino acids and non-essential amino acids, essential amino-acid could not be compounded by human beings, but originating from food supply.

We could see from Table 2 that:

Table 1: The content of essential nutrient ingredient in several wild edible fungus of Yunnan province (g/100 g)

| Nutritional ingredient | *Green mushroom* | *Lactarius deliciosus* | *Lactarius volemus* | *Lactarius hatsudake* |
|---|---|---|---|---|
| Edible part/% edible/% | 85.5 | 83.7 | 84.6 | 85.5 |
| Moisture water | 93.5 | 92.3 | 94.0 | 89.2 |
| Thermal energy/kcal/% | 16.0 | 20.0 | 14.0 | 28.0 |
| Fat | 0.1 | 0.2 | 0.4 | 0.1 |
| Protein | 2.6 | 2.2 | 1.4 | 2.3 |
| Carbohydrate | 0.8 | 2.0 | 0.9 | 4.3 |
| Dietary fiber | 2.3 | 3.0 | 2.5 | 3.6 |
| Ash | 0.9 | 0.6 | 0.8 | 0.7 |
| Nutritional ingredient | *Thelephora ganbajun* zang | *Boletus speciosus* | *Boletus edulis* | *Morel* |
| Edible/% | 85.6 | 91.0 | 93.0 | 90.0 |
| Water | 86.5 | 89.5 | 90.6 | 14.3 |
| Thermal energy/kcal/% | 17.0 | 32.0 | 29.0 | 24.0 |
| Fat | 0.4 | 0.3 | 0.4 | 7.1 |
| Protein | 3.7 | 4.2 | 4.0 | 26.9 |
| Carbohydrate | 2.1 | 3.0 | 3.2 | 2.0 |
| Dietary fiber | 6.3 | 2.2 | 1.5 | 12.9 |
| Ash | 1.3 | 0.8 | 0.9 | 8.0 |

Table 2: Amino acid content of several wild edible fungus in Yunnan province (mg/100 g)

| Amino acid | *Green mushroom* | *Lactarius deliciosus* | *Lactarius volemus* | *Fresh soybean* | Whole egg |
|---|---|---|---|---|---|
| Threonine | 137 | 95 | 85 | 538 | 577 |
| Valine | 131 | 130 | 99 | 619 | 699 |
| PHE | 143 | 85 | 77 | 612 | 622 |
| Methionine | 90 | 38 | 17 | 108 | 363 |
| Lysine | 83 | 98 | 48 | 841 | 850 |
| Leucine | 166 | 224 | 206 | 1122 | 1046 |
| Isoleucine | 133 | 131 | 146 | 601 | 629 |
| Tryptophan | 36 | 30 | 17 | 142 | 222 |
| Arginine | 96 | 104 | 89 | 920 | 736 |
| Glutamic acid | 226 | 346 | 352 | 2547 | 1565 |
| Histidine | 75 | 64 | 23 | 370 | 270 |
| Proline | 130 | 80 | 23 | 659 | 436 |
| Glycine | 128 | 120 | 83 | 588 | 390 |
| Aspartic acid | 250 | 164 | 137 | 1701 | 1155 |
| Serine | 140 | 86 | 70 | 734 | 867 |
| Tyrosine | 169 | 85 | 33 | 490 | 492 |
| Alanine | 117 | 184 | 105 | 611 | 649 |
| Cystine | - | - | - | 201 | 245 |
| Essential amino acid | 926 | 835 | 692 | 4619 | 5008 |
| Sum | 2251 | 2076 | 1610 | 13403 | 11807 |
| Essential amino acid/total amino acid | 0.41 | 0.41 | 0.43 | 0.35 | 0.42 |
| Amino acid | *Thelephora ganbajun* zang | *Boletus speciosus* | *Boletus edulis* | *Morel* | |
| Threonine | 146 | 84 | 87 | 96 | |
| Valine | 335 | 246 | 171 | 117 | |
| PHE (phenylalanine) | 130 | 49 | 27 | 75 | |
| Methionine | 33 | 16 | 7 | 29 | |
| Lysine | 119 | 52 | 81 | 116 | |
| Leucine | 527 | 129 | 40 | 248 | |
| Isoleucine | 535 | 106 | 48 | 86 | |
| Tryptophan | 38 | 30 | - | - | |
| Arginine | 140 | 62 | 32 | 175 | |
| Glutamic acid | 475 | 189 | 303 | 306 | |
| Histidine | 41 | 57 | 59 | 36 | |
| Proline | 60 | 68 | 81 | 69 | |
| Glycine | 149 | 154 | 126 | 94 | |
| Aspartic acid | 230 | 164 | 134 | 174 | |
| Serine | 127 | 59 | 68 | 78 | |
| Tyrosine | 78 | 26 | 31 | 53 | |
| Alanine | 254 | 261 | 220 | 111 | |
| Cystine | - | 86 | 144 | 21 | |
| Essential amino acid | 1863 | 739 | 520 | 819 | |
| Sum | 3417 | 1778 | 1659 | 1913 | |
| Essential amino acid/total amino acid | 0.55 | 0.42 | 0.32 | 0.43 | |

- The variety of amino acids in these 8 fresh samples of wild edible fungus is relatively complete, each wild fresh bacterium contains 17 kinds of amino acids and boletus specious contains 18 amino acid. Except for delicious cow bacilli and tripe, all the other bacteria have rich essential amino acid of human body. It indicates that most of the wild edible fungus could replenish the essential amino-acid for human body (Can *et al*., 2012).
- The content of essential amino-acid in protein is 32-55%, the constitution of amino acid in wild mushroom is obviously superior than composition

Table 3: The content of inorganic element in several wild edible fungus of Yunnan province (mg/100 g)

| Inorganic element | *Green mushroom* L. | *Lactarius deliciosus* | *Lactarius volemus* | *Lactarius hatsudake* | *Dried mushroom* | *Boletus speciosus* | *Boletus edulis* | *Morel* |
|---|---|---|---|---|---|---|---|---|
| K | 265 | 217 | 249 | 205 | 32.80 | 295 | 301 | 44.50 |
| Ca | 3.90 | 7.10 | 4.00 | 3.10 | 10 | 4 | 5 | 0.80 |
| P | 53.00 | 69 | 26 | 50 | 104 | 58 | 68 | 56.90 |
| Na | 1.10 | 1.70 | 1.20 | 1.10 | 2.10 | 1.60 | 2.10 | 0.58 |
| Mn | 0.10 | 0.37 | 0.11 | 0.24 | 0.67 | 0.16 | 0.19 | 0.04 |
| Mg | 8.50 | 11.20 | 5.00 | 10.50 | 11.00 | 9 | 10 | 0.62 |
| Fe | 1.40 | 20.40 | 5.90 | 4.70 | 21.00 | 1.70 | 2.10 | 0.84 |
| Cu | 0.34 | 0.12 | 0.25 | 0.08 | 0.30 | 0.43 | 0.32 | 0.03 |
| Zn | 0.65 | 1.15 | 0.42 | 1.05 | 0.78 | 1.68 | 0.98 | 0.12 |
| Se/ug | 0.23 | 0.28 | 0.13 | 0.29 | 0.46 | 0.25 | 0.25 | 0.02 |

Table 4: The content of vitamin in 3 kinds of wild edible fungus belonging to red mushrooms type in Yunnan province (mg/100 g)

| Vitamin lactarius | *Volemus lactarius* | *Deliciosus green* | *Mushroom dried* | *Mushroom boletus* | *Speciosus boletus* | *Edulis* |
|---|---|---|---|---|---|---|
| Riboflavin | 0.46 | 0.75 | 0.60 | 1.84 | 0.14 | 0.14 |
| Nicotinic acid | 4.20 | 2.30 | 2.80 | … | 2.40 | 2.10 |
| Thiamine | 0.07 | 0.08 | 0.02 | 0.06 | 0.14 | 0.14 |
| Vitamin E | … | 3.15 | … | 45.14 | 9.76 | 8.93 |
| Ascorbic acid | … | … | … | … | … | … |
| Carotene | … | … | … | … | … | … |

Table 5: The influence of traditional cooking and processing on the content of $V_{B_1}$ and $V_{B_2}$ in fresh edible fungus (mg/100 g)

| | $V_{B_1}$ content (thiamin content) | | | $V_{B_2}$ content (riboflavin content) | | |
|---|---|---|---|---|---|---|
| Name | Before cooking | After cooking | Loss ratio/% | Before cooking | After cooking | Loss ratio/% |
| *Green mushroom* | 0.021 | 0.010 | 50.0 | 0.451 | 0.282 | 35.5 |
| *Lactarius volemus* | 0.070 | 0.041 | 42.8 | 0.561 | 0.401 | 28.6 |
| *Lactarius deliciosus* | 0.081 | 0.050 | 37.5 | 0.750 | 0.410 | 49.3 |
| *Boletus speciosus* | 0.140 | 0.112 | 21.4 | 0.990 | 0.451 | 54.5 |
| *Boletus edulis* | 0.140 | 0.081 | 42.9 | 1.110 | 1.021 | 8.1 |
| *Dried mushroom* | 0.036 | 0.035 | 90.1 | 1.592 | 1.260 | 75.1 |

of beans (except for boletus edulis), it is almost close to the whole egg, the composition of *Thelephora ganbajun* zang is superior than whole egg. Thus, the protein of wild edible fungus belongs to fine protein.

- Aspartic acid and glutamic acid is flavor amino acid, all the 8 kinds of bacterium have rich aspartic acid and glutamic acid, its content is 19-26%, this is why it is delicious.

**The content of inorganic element in wild edible fungus of Yunnan province (Table 3):** We could see from Table 3 that: the detection result of above 10 inorganic elements indicates that, 8 kinds of wild edible fungus have rich zinc (Zn), potassium and iron. The content of iron in *Lactarius deliciosusm* and dried mushroom is the highest; it is close to pork liver which has the richest iron, which is about dozens of times of iron content in general vegetable. There exists the highest difference in the content of copper, there exists more than 10 times the difference between highest and lowest content, in addition to that it has rich potassium the content of phosphorus and magnesium is also relatively high, the content of calcium is relatively low (3.0-10 mg/100 g), it is only the 1-10% of general colored vegetables, its content of sodium (Na) is relatively lower when compared to general vegetables (Kalac, 2010).

**The content of vitamin in wild edible fungus of Yunnan province (Table 4 and 5):** We could see from Table 4 that: All the 8 kinds of bacterium has certain amount of thiamine and riboflavin, thiamine is called $V_{B_1}$, riboflavin is called $V_{B_2}$, its content is close to cabbage, celery and lean meat. $V_{B_1}$ Participates in the catabolism of sugar in the form of coenzyme, it not only has the effect of protecting nerve, but also could promote the peristalsis of intestines and stomach. $V_{B_2}$ Could prevent and cure cardiovascular disease and migraine, also have certain curative effect on some senile diseases. *Dried mushroom* has rich vitamin E, whose content is as high as 45.14 mg/100 g; vitamin E has the effect of oxidation resistance and delaying senescence.

We could see from Table 5 that: All the several kinds of wild edible fungus have $V_{B_1}$ and $V_{B_2}$. The content of $V_{B_2}$ is the richest, it is the 14-28 times of that in tomatoes, 47-75 times of that in *Benincasa hispida*, it is a kind of superior food with $V_{B_2}$. However, cooking and processing would damage the content of $V_{B_1}$ and $V_{B_2}$. Under this experimental condition, carotene and $V_C$ are detected among 8 kinds of red mushroom (Table 4), it represents that most of the wild edible fungus are in short of carotene and $V_C$.

## DISCUSSION

Through making analysis for the nutrition ingredient of several wild fungus in Yunnan province, the results indicate that there exists difference but not big among the variety of such nutrient substance as

amino acids, inorganic elements, vitamin contained in different bacterial. Through making analysis for the results of 8 wild funguses, all of them have high content of protein and dietary fiber and the content of morel is the highest, but it does not have the required 8 kinds of amino acids in human body. As a whole, these fresh samples of 8 wild fungus have relatively comprehensive variety of amino acid, their nutrition ingredient is almost close to whole egg and has abundant fresh amino acid (glutamic acid and aspartic acid). In addition to that, through detecting the inorganic elements and vitamins, we could know that all these 8 kinds of wild fungus have abundant zinc, potassium, iron, $V_{B_1}$, $V_{B_2}$ and the content of iron and $V_{B_2}$ in dried mushroom is the most abundant.

Through making analysis for the nutrition ingredient of 8 wild funguses in scenic spots in Yunnan province, it is estimated that most of the wild edible fungus have the characteristics of high quality protein, high iron, potassium, zinc, low sodium, fat and calories, which is beneficial to improve body protein, prevent obesity and high cholesterol. The study indicates that most of the wild edible funguses developed in Yunnan province are rich in nutrients, which could supplement essential nutrients, minerals, microelement of human body. Recently, iron and zinc are two of the essential elements that a Chinese person lacks. Thus, eating more edible fungus is good for absorbing iron, zinc and $V_{B_2}$. However, through experimental analysis, the content of some vitamin in edible fungus is extremely low and some vitamin would be destroyed during cooking. Thus, reasonable collocation and cooking methods should be taken care to make up for its nutrient deficiencies.

Yunnan province has various variety of wild edible fungus, most of the recently developed wild fungus contains a lot of nutrient substance, such as amino acid, protein, vitamins and minerals and so on and they also have the effect of health care. As Yunnan province has various variety of wild edible fungus, it has attracted high-quality talent all over China to visit study and develop wild fungus in Yunnan province; in the meantime, it would attract people to study related knowledge about eating and cooking wild fungus in Yunnan, by which to drive the development of rural tourism industry in Yunnan province.

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