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Nutritional Analysis of *Morchella conica* and its Role on Rural Livelihood

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Abstract

The multipurpose Himalayan mushroom *Morchella conica* is one of the most popular wild high valued edible mushrooms throughout the world. It makes a good income generating source for rural livelihood. This study mainly focuses on the nutritional constituents of *M. conica* and its medicinal uses with social and financial values for rural livelihood. Nutritional analysis was conducted based on moisture, ash, crude fats, proteins and carbohydrates. The highest value of carbohydrate was 36.5% followed by protein 35.0%, crude fiber 28.8%, crude fat 12.0%, ash 8.2% and moisture 8.0%. In social and financial aspects of *M. conica* in the studied area, 20% ethnic groups involved for collection of this species. *M. conica* is economically high priced in which 60.0% poor and 53.3% medium class people are considering this to support their livelihood. The study also showed that this species is a potential source of diet and income for rural people.

Key words: carbohydrate, diet value, edible, protein, proximate analysis

Introduction

Non-timber Forest Products (NTFPs) have attracted considerable global interest. This is due to the increasing recognition of the fact that NTFPs can provide community needs for improving rural livelihood, contribute to household food security and nutrition (FAO 1995, Chang 1999, ACAP, 2007). It helps to generate additional employment, income and other conservation objectives if organized scientifically and on a sustainable basis (Manandhar, 2003). In Nepal, out of several MAPs, *Morchella conica* have significant contribution due to its medicinal and nutritional properties. It is one of the most important and prioritized plants species listed by Ministry of Forest and Soil Conservation of Nepal (DPR, 2006). It occurs from temperate to sub- alpine in the wet and shady areas of Western Himalayas at an altitude of 1,800-3,500 m. It is an annual, non-chlorophyllous and saprophytic fungus. The fungus grows vigorously near and beneath the fallen trees of the previous year, where good humus has been formed. It is found nicely grown in the fire burn and dense coniferous forest. Its natural habitat depends upon the rainfall/snowfall in the month of March and April (Hertog, 1993).

Whole body of the *M. conica* collected from the Himalayas is used for the various delicious and nutritional foods in expensive international star hotels and restaurants, mostly in Europe and Japan (Hertog, 1993). It is consumed internationally under the trade name of Himalayan Mushroom. In average, 5-10 tones of *Morchella* are produced from Nepal. There is about 150 tones of *Morchella* demand/year in international market (Himalayan Morel Mushroom, 2009). Though

there is increasing market of *Morchella* spp. in the world, its distribution pattern, cultivation and conservation measures have not yet been implemented in Nepal. The collection of such mushroom is limited only from natural stands as no farming system has yet been developed. At lower Mustang in Annapurna Conservation Area Project (ACAP) region, one collector can normally harvest 2-6 kg. of fresh *M. conica*/day depending upon the habitat, quantity and its availability.

People consider that nutrition may vary, but usually it includes carbohydrates, proteins, fats, ash, moisture and crude fibers. Nutritional analysis of edible plant materials such as mushrooms, vegetables and fruits plays a crucial role in assessing their nutritional significance (Pandey *et al*. 2006). Evaluating their nutritional significance can help to understand the worth of these species (Pandey *et al*. 2006). Collection of data during the social survey gives idea about the quantity of *M. conica* that the rural people are taking as the food and income for livelihood. The result obtained from nutritional analysis of *M. conica* will fulfill the gaps to evaluate its role on rural livelihood and the diet of people in a more scientific way.

Methodology

Site selection

The lower Mustang of Annapurna Conservation Area was selected for availability of *M. conica* on the basis of suggestions made by ACAP office, Pokhara. Kunjo VDC of lower Mustang was selected by the discussion made with local healers.

Socio-economic data collection

The socio-economic date was collected by means of primary and secondary date collection.

Primary data

In order to collect the most reliable and useful information regarding the study, primary data were collected by using different tools as described below:

Questionnaire survey

The knowledgeable persons who were local healers, MAPs collectors, the head teacher of local school, staffs of local CBOs and users were invited in questionnaire.

Direct observations

Observations were made in the study area to collect more information regarding the resource identification, management practices of *Morchella* spp.

Formal and informal discussion

Both formal and informal discussions with forestry professionals, key informants, committee members, village elders, farmers, local leaders, women, school teachers, social workers, members and staffs of local NGOs, were consulted to identify and verify the facts.

Secondary data

Different journals, articles, thesis, publications, maps and web sites were used for gathering information.

Collection of plant materials and sample preparation

Fresh samples of the *M. conica* were collected from the field. After cleaning it manually to remove any extraneous materials, the analyses were carried out. The collected materials were then dried at 65 °C in oven until their weight became stable and it was powdered. Moisture content was determined from the fresh material whereas the total carbohydrate, fat, protein, ash and crude fiber were determined from the oven-dried powder (AOAC, 1990). The dried fine powder was stored at 5 °C in the air-tight containers prior to further analysis.

Nutritional analysis

The moisture and ash were determined using the weight difference method. The nitrogen value, which is the precursor for protein of a substance, was determined by micro-Kjeldahl method described by Pearson (1976) which involves digestions, distillation and titration of the sample. The nitrogen value was converted to protein by multiplying a factor of 6.25. Carbohydrate was then determined by the difference method.

Determination of the moisture

One gram of *M. conica* was taken in a Petri-dish and placed in the oven at 100 °C for four hours. It was then cooled in desiccators and weighed. The sample was heated again in the oven for another two hours and the process was repeated, till a constant weight obtained. The moisture content was calculated by

using following formula. This process was repeated twice for getting a precise data.

$$\text{Moisture (\%)} = \frac{\text{Weight of fresh sample – Weight of dried sample}}{\text{Weight of sample}} \times 100$$

Determination of ash

One gram dried sample was taken in a crucible. The sample was charred over a low flame and kept in a muffle furnace set at 550 °C until white ash was obtained. The ash was moistened with water, dried on steam and then on hot plate. The crucible was again placed in the muffle furnace at 550 °C, till a constant weight was obtained. The percent ash was calculated as:

$$\text{Ash (\%)} = \frac{\text{Weight of sample after ash}}{\text{Weight of sample}} \times 100$$

Determination of crude fat

The dried sample was taken and crushed. 2.0 g of the sample was taken in the paper thimble and connected to a soxhlet extractor. 300 mL of petroleum ether was poured on the flask and refluxed for 12 hours with a heating mantle. Crude fat was extracted on the flask. The flask was cooled in a desiccators and the weight was taken. The percent crude fat was determined by using formula:

$$\text{Cube fat (\%)} = \frac{\text{Weight of flask with fat - weight of empty flask}}{\text{Weight of original sample}} \times 100$$

Determination of crude fiber

One gram of the defatted plant material was taken in a beaker and boiled in 200 mL of 1.25% sulphuric acid for 30 minutes. The content was then filtered and washed with distilled water to neutralize the content. The content was transferred again to the beaker and boiled in 200 mL of 1.25% sodium hydroxide for 30 minutes. It was again filtered and washed with distilled water for neutralization. A Gooch crucible was prepared with an asbestos mat and content of the beaker was placed on the mat and washed with 15 mL of ethyl alcohol. The crucible was dried in an oven at 110 °C to a constant weight. The crucible having crude fiber was cooled and weighed (W1).

The content of the crucible was ignited over a low flame until charred and then kept in a muffle furnace at 550 °C and weighed (W2).

The percentage fiber was determined from the formula:

$$\text{Crude fiber (\%)} = \frac{W1 - W2}{\text{Weight of sample}} \times 100$$

Determination of protein by micro Kjeldahl's method

The protein determination is divided into three steps:

A. Digestion

0.5 g of dried plant material was taken in the digestion flask. To this 1.0 g of the digestion mixture (copper sulphate and potassium sulphate, 1:18) and 7 mL of concentrated sulphuric acid was added. The solution was heated until it became clear and frothing ceased. It was then boiled gently for another 2 hours, cooled and digest with 30 mL of water with constant mixing. The digest was transferred to 100 mL volumetric flask and add necessary amount of water up to the mark of the flask.

B. Distillation

The Parnas Wagner distillation assembly was arranged. 25 mL of 4% boric acid was taken and 1 drop of methyl red indicator was added, by which pink color can be observed. 5 mL of the digest was transferred to the distillation assembly and 10 mL of 32% sodium hydroxide solution was added on it. The distillation was completed in 10 minutes indicated with change of color of boric acid to yellow due to the formation of ammonium borate.

C. Titration

The boric acid having trapped ammonia was titrated with 0.1N hydrochloric acid, the colour of boric acid having ammonia changed again to pink. The percent protein was calculated by the formula:

$$\text{Protein (\%)} = \frac{1.4 \times 6.25 \times 0.1N\ HCl \times Vol\ (used)}{\text{Weight of sample}}$$

Where;

1.4 = Weight of nitrogen expressed in gram in the formula

6.25 = Protein factor

Determination of carbohydrate

Carbohydrate was determined by difference, using following formula:

Carbohydrate (%) = 100 - (moisture + crude fat + ash + protein)

Results and Disscussion

Contribution of *M. conica* on rural livelihood

M. conica plays vital role to the people of communities of Himalayas dwelling adjacent to the forest. It is one of the main sources of income of the rural people for their livelihood. The *Morchella* spp. has become a means to increase natural and financial capital of the rural people.

Contribution to natural capital

Natural capital is the term used for the natural resource stocks from which resource flows and services (e.g. nutrient cycling, erosion protection) useful for livelihoods are derived. There is a wide variation in the resources that make up natural capital, from intangible public goods such as the atmosphere and biodiversity to divisible assets used directly for production e.g. trees, land, etc. (DFID, 1999). From all the studied of Kunjo VDC of Mustang district, it has been shown that the improved and more sustainable forest product flows are due to the progress on the condition of the forest resource popularly said as 'natural capital'. Many people are improving their forest resources. The availability of *M. conica* of the VDC is one of the natural capitals from the recognition of users.

From analysis of *M. conica* in each individual respondents of the Kunjo VDC, 52.95% respondents have explained that the resource condition of this species is declining followed by normal condition as 35.29% and abundant condition as 11.76%, respectively (Table 1).

Table 1. People's recognition about the resource condition of *M. conica*

Parameters	Frequencies	Percentage
Abundant	4	11.76
Normal	12	35.29
Declining	18	52.95

*Parentheses in the table show the percentage values.

Response exercises were carried out to find out the respondents opinion on causes of declining of *M. conica* (Table 2). The declining of *M. conica* was due to over exploitation 32.35%, followed by unknown about value 26.47%, premature harvesting 23.52%, inappropriate harvesting 8.82%, free grazing 5.88% and encroachment 2.94%. Over exploitation by nearby villager as well as elite people who knows about the real value of *M. conica* were the most problematic cause and encroachment by the nearby villager is less than other causes of its declining.

Table 2. Main causes of declining of *M. conica* by focus group discussion of the respondents.

Causes of declining	Frequencies	Percentages
Over exploitation	11	32.35
Unknown about value	9	26.47
Premature harvesting	8	23.52
Inappropriate harvesting	3	8.82
Free grazing	2	5.88
Encroachment	1	2.94

Access over the resources of *M. conica* varies according to socio-economic condition of people. When the question is asked based on the statement and judged, the level on access over the resources was found as presented in table 3.

Table 3. Satisfaction level on access over the resources of *M. conica* w.r.t. wealth ranking.

Wealth ranking	Response frequency (%) on satisfaction level		
	Highly satisfied	Satisfied	Less satisfied
Poor	9 (60)	4 (26.67)	2 (13.33)
Medium	8 (53.33)	7 (46.67)	0
Rich	1 (25)	3 (75)	0

**Parentheses in the table show the percentage values.*

Table 3 portrays that poor people were highly satisfied about the access over the resources of *M. conica* in contrast to rich and medium people and some wealth ranking discrimination was appeared about access over the resources of *M. conica*. It clarified that some restriction posed on the access over the resources of *Morchella*.

Contribution to financial capital

Forests provide a wide variety of useful resources for rural households. These resources have a range of economic functions-sustaining consumption, generating cash income, providing agricultural inputs, proving input for small–scale enterprises and underpinning capital formation. The fund generated from the sale of forest products, tax and other grants are the financial capital created through forests. The forest has been providing almost all the production factors to the rural people.

Indirect money value of *M. conica*

People of Kunjo VDC of Mustang collect *M. conica* mainly for selling and a little bit for household purposes for the curry and diet. Table 4 shows that the poor and medium class people are much more dependent on the diet and foods for health care based on *M. conica* than that of rich. Also, poor and medium are highly satisfied than rich. However, the rich people are somewhat reluctant towards the diet and food from the *M. conica*, but still agree that the indirect money value is great.

Table 4. Response frequencies (%) on satisfaction level based on MAPs

Wealth ranking	Response frequency (%) on satisfaction level			
	Highly satisfied	Moderately satisfied	Poorly satisfied	Not at all satisfied
Poor	7 (46.67)	3 (20)	2 (13.33)	3 (20)
Medium	4 (26.67)	4 (26.67)	4 (26.67)	3 (20)
Rich	0	2 (50)	1(25)	1(25)

**Parentheses in the table show the percentage values.*

Medicinal Values of M. conica

Most of the people use *M. conica* for treating wound heeling together with anti-inflammatory, fever, ulcers and colitis, anti-carcinogenic and equally used for immunosuppressive and antibiotic. According to figure 1, majority of people use *M. conica* for heeling wound (29.03%) followed by anti-inflammatory, fever, ulcers and colitis, anti-carcinogenic and least use for immunosuppressive and antibiotic (3.23%).

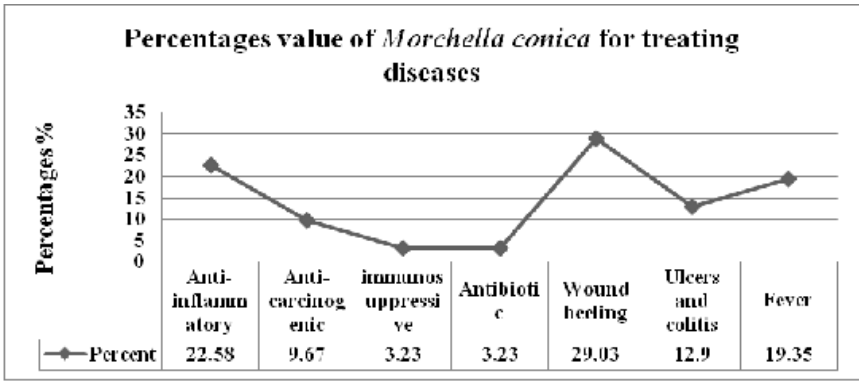

Fig. 1. Medicinal uses of *M. conica* for different diseases in percentages

Direct money value of *M. conica*

The percentages of poor and medium class people are highly involved in the collection of the *M. conica* than the rich people (Figure 2). It is shown that poor and medium class people are more dependent than rich people for livelihood. This shows that overall involvement of all class of people in collection of *M. conica* is high due to high priced and most valuable for dietary in health care and medicinal purposes.

Table 5 shows that contribution of *M. conica* in poor class people is second importance for livelihood after agriculture. The poor and medium class people were depending upon the *M. conica* collection and derived income for livelihood than rich people.

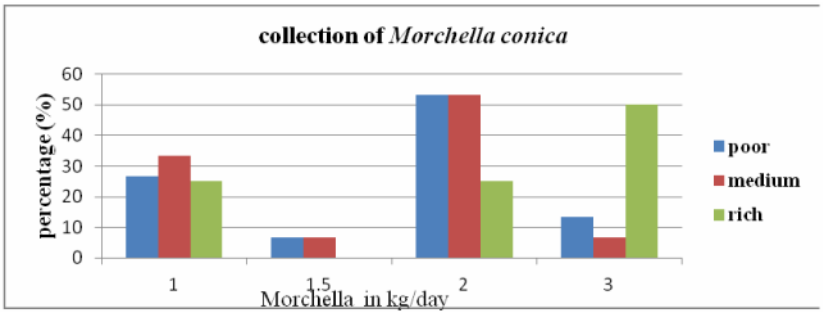

Fig. 2. collection of *M. conica* with respect to wealth ranking.

Table 5: The occupation of the respondents w.r.t. wealth ranking for livelihood.

The contribution of the occupation of respondents & income for their livelihood

Wealth ranking of the respondents	Agriculture	Business	Labor	Livestock	*M. conica*	Service	Total
Poor	7 (46.67)	1 (6.67)	1 (6.67)	1 (6.67)	3 (20)	2 (13.33)	15 (100)
Medium	6 (40)	2 (13.33)	2 (13.33)	1 (6.67)	3 (20)	1 (6.67)	15 (100)
Rich	1 (25)	1 (25)	1 (25)	1 (25)	0	0	4 (100)

**Parentheses in the table show the percentage values*

Nutritional Analysis

Nutritional analysis of the *M. conica* was carried out in the Medicinal and Aromatic Plants Laboratory at Institute of Forestry, Pokhara, Nepal. The nutritional (moisture, ash, crude fats, proteins and carbohydrates) analysis of the clean and dried *M. conica* were determined (Table 6). All the nutritional values of the *M. conica* were reported in % by various laboratory methods, as described in methodology section.

The nutritional analysis of the *M. conica* showed that it consists of highest value of carbohydrate 36.50% followed by protein 35%, crude fiber 28.8%, crude fat 12%, ash 8.25% and moisture 8% (Table 6).

Table 6. Nutritional compounds determined from the *Morchella* spps. and their values in percentage

Nutritional composition of *Morchella conica*	**Nutritional values in percentage (%)**
Moisture	8
Ash	8.25
Crude fat	12
Crude fiber	28.8
Protein	35
Carbohydrate	36.75

The valuable Himalayan mushroom *M. conica* found to have significant role in rural livelihood and nutritional value. About 20% of the local people embroiled for collection of *M. conica* and level of satisfaction of rural people is 72.22%. Both poor and medium class people are highly involved in collection of *M. conica* than rich class people. The collection of such mushroom is limited only from natural stands as there is no farming system developed. Collectors simply sell *M. conica* to the local traders or road head traders. The main causes of the dwindling of *M. conica* are lack of conservation practices, overexploitation, free grazing, encroachment, lack of education, trainings and awareness, lack of knowledge about its nutritional importance. There is growing concern of *Morchella* spps. regarding the nutritive value of foods and to nourish the ever increasing population and the inadequacy of essential nutrients can be improved through fortifications and enrichment of food vehicles. Mushroom is one of the useful, delicious and mysterious members of the biosphere. The nutritional analysis of the *M. conica* indicated that it contains

significant amount of carbohydrate, protein, crude fiber, crude fat and moisture that are necessary for our daily life. It also provides high medicinal values for treating various diseases such as wound heeling 29.03% followed by anti-inflammatory 22.58%, fever 19.35%, ulcers and colitis 12.90%, anti-carcinogenic 9.67% and least use for immunosuppressive and antibiotic 3.23% as well as high nutritional diet to rural people and economically high priced for livelihood.

The main purpose of the analysis of financial and natural contribution of *M. conica* is to aware the respondents for conservation and sustainable production of this valuable species for the livelihood of the local people by generating incomes by selling, fulfilling food and diet requirement and medicinal purposes for the poor people who are deprived of treatment for the diseases. The attraction of the local people for the conservation and sustainable production of *M. conica* by linking with their livelihood assets and defining the value and importance for their livelihood, income, therapeutic values as well as rocketing demand of this species in National and International Markets.

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