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SUMMARY AND CONCLUSION
CHAPTER 5
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Today the world over is suffering and dying from chronic degenerative diseases. The main causes of these degenerative diseases are free radicals. Free radicals and other highly reactive oxygen compounds are believed to contribute to the causation of a wide variety of human diseases especially the chronic disease associated with aging. It is time to realize that foods can not only prevent disease but also help in promoting health. A well balance diet contains all essential nutrients which are necessary for good health, but there are certain dietary factors, which go further than meeting our recommended dietary intakes. Nutraceuticals are products that are isolated or purified from foods and generally sold in medicinal forms not usually associated with food (tablets, capsules, drops, and tonic) that may have physiological benefit and/or have the ability to reduce the risk of chronic diseases beyond basic nutritional functions. Now a day conventional and unconventional foods are used as nutraceuticals. Mushroom is an unconventional food recognized as a food and drug. Oyster mushrooms are well known for their nutritional and medicinal potential besides for its simple and low cost cultivation technology. Considering all these points, oyster mushrooms were selected for preparation of nutraceuticals.

The objectives of the present study are to determine the nutritional contribution of fruiting and mycelium of oyster mushroom, to determine effect of oyster mushroom doses of fruiting and mycelium on growth of albino rats, to study the effect of oyster mushroom doses on plasma lipid level of albino rats, to study the effect of oyster mushroom doses of fruiting and mycelium on blood glucose level of diabetic adult albino rats and to find out the cost benefit of oyster mushroom doses of fruiting and mycelium.

The present investigation was a multivariate experimental research design in which seven variables were under study including control variable. Six diets were supplemented with oyster mushroom doses and one was control which was without supplementation. Under the dependent variable nutritional composition, therapeutic effects and cost benefits were studied. In nutritional composition proximate composition, nine essential amino acids and eight minerals were estimated. Three animal experiments were carried out on albino rats. First was to study the in vivo
effect of oyster mushroom doses on growth of albino rats, second was to study the in vivo effect of oyster mushroom doses on plasma lipid level of albino rats and last one was the in vivo effect of oyster mushroom doses on blood glucose level of diabetic albino rats.

The present study was conducted in the department of Home Science, Sant Gadge Baba Amravati University, Amravati. Nutrition analyses were carried out in the Biochemistry laboratory. A separate animal house was set up for feeding albino rats.

Oyster mushroom was cultivated by polybag technique and mycelium was grown on agar-agar and potato media. Fruiting and mycelium of oyster mushroom were harvested form bags and media, respectively. Both were dried at 30-32°C temperature in the incubator. Fruiting and mycelium were ground to form fine powder. Fine powders were stored in airtight container for feeding purpose.

Oyster mushroom fruiting as well as mycelium was subjected to nutrient analyses, which includes proximate analysis of (moisture, ash, fat, protein, fibre and carbohydrate), essential amino acid (phenylalanine, lysine, leucine, isoleucine, threonine, tryptophan, methionine, histidine and valine). Besides Deoxy Ribose Nucleic Acid and Ribose Nucleic Acid were estimated to find out the safe level for human consumption. Under minerals analysis estimations of sodium, potassium, phosphorus, calcium, iron, copper, zinc and manganese were carried out by standard AOAC methods.

Animal experiments were carried out to find out the therapeutic effects of oyster mushroom doses. Wister albino rats were purchased from Department of Biochemistry, Rashtra Sant Tukdoji Maharaj Nagpur University, Nagpur. The weights of animals were between 50 to 60 grams and age was between 40 to 45 days. Before commencement of the experiment, all rats were fed with standard diet, then were divided into five groups. Each group comprised 6 rats. Under growth studies, control and experimental diets were prepared and fed to respective group of albino rats. The duration of the experiment was 30 days. On every 10th day, animals were weighed. Their food intake and remnant food were recorded. Water was provided in ad-libitum.

In second animal experiment, the effect of oyster mushroom doses on plasma lipid level of albino rats was studied for which similar groups were formed as formed in growth experiment. Control and experimental diets were fed for 30 days. At the end of experiment, blood samples were collected after 8 to 20 hours fasting from orbital
sinus puncture. Blood samples were subjected for estimation of total cholesterol, high-density lipoproteins, triglyceride and low density lipoprotein concentration.

The last experiment dealt with *in vivo* effect of the oyster mushroom doses on blood glucose level of diabetic albino rats. The study was carried out on 20 alloxan-induced diabetic albino rats. All the diabetic rats were randomly divided into five groups including one control group. The control and experimental diets and water were given to rats in ad-libitum. The duration of experiment was for 15 days. All the rats were weighed before commencing the experiment and after every 5th day. On initiation of experiment and on every 5th day blood samples were collected and subjected to estimate *in vivo* fasting and post meal blood glucose.

Cost benefit of oyster mushroom doses was calculated by converting actual cost of doses, protein contribution and therapeutic benefits. Protein contribution and therapeutic benefits were quantified by allotting scores.

The various observations recorded during the experiment were processed for the analyses of means and standard deviations, means of nutritional composition of fruiting and mycelium were compared by applying 't' test. Observations of various parameters i.e. weight, plasma lipid level and blood glucose were computed for means and standard deviations. To compare the effect of control and experimental diets one way and two way ANOVA tests were applied.

5.1 Summary of the results

The results of the study on nutritional potential of oyster mushroom reveal that the fruiting and mycelium of oyster mushroom are excellent source of protein. Mycelium (47.08%) contained significantly more protein than the fruiting (33.66%). Mycelium protein value was more than soybean (43.20%) and milk powder (25.80%). Fruiting contained (10.15%) significantly more fibre than mycelium (9.50%). Fruiting and mycelium contained 2 and 3.2 per cent fat, respectively which indicate poor source of fat. The ash and moisture contents of fruiting and mycelium were nearly same.

Fruiting and mycelium of oyster mushroom contained 3.86 per cent and 3.99 per cent nucleic acid, respectively. This reflects that fruiting and mycelium both were very low in nucleic acid, even lower than spirulina (4%) and yeast (6 to 8%).
Oyster mushroom fruiting and mycelium contained all essential amino acids. Fruiting contained 4.00 per cent and mycelium contained 6.50 per cent phenylalanine, it shows that mycelium was significantly better than fruiting in respect of phenylalanine. Fruiting and mycelium comprised 5.10 and 4.30 per cent valine, respectively. Fruiting had more valine than mycelium. Fruiting and mycelium comprised 2.20 per cent and 2.60 per cent methionine, respectively. The amount of tryptophan present in fruiting (1.50%) was lower than mycelium (2.10%). Mycelium was (7.50%) better than fruiting (5.10%) in respect of threonine. Isoleucine present in mycelium (4.20%) was slightly lower than fruiting (3.40%). Leucine present in fruiting (6.50%) was greater than mycelium (5.20%). Fruiting contained 6.40 per cent lysine and mycelium contained 7 per cent lysine. Mycelium had greater amount of lysine than fruiting. Fruiting and mycelium both contained histidine in equal amount.

Quality protein depends on presence of all essential amino acids in food; as such oyster mushroom mycelium and fruiting contained all essential amino acids. The values of phenylalanine, methionine, tryptophan, threonine, isoleucine, lysine and histidine present in mycelium were more than fruiting of oyster mushroom.

Fruiting and mycelium contributed 2300mg/100g and 2100mg/100g potassium, respectively. Amount of sodium present in fruiting (220mg/100g) and mycelium (90mg/100g) was very low. Fruiting contained 1936mg/100g and mycelium contained 1660mg/100g phosphorus. These values indicate that fruiting was better than mycelium in respect of phosphorus. Fruiting and mycelium provided 250mg/100g and 390mg/100g calcium, respectively. Mycelium comprised better amount of calcium than fruiting.

Fruiting and mycelium comprised 9.53mg/100g and 5.60mg/100g iron, respectively. This shows that fruiting contained more amount of iron than mycelium. Fruiting and mycelium provided 52mg/100g and 58mg/100g zinc, respectively. These values show that mycelium contained slightly more zinc than fruiting. Mycelium (43mg/100g) was better than fruiting (36mg/100g) in respect of copper also. Fruiting and mycelium comprised 65mg/100g and 64mg/100g manganese, respectively which is nearly equal.

Effect of oyster mushroom doses on growth of albino rats revealed that 2g OMF and 2g OMM dose fed groups showed better weight gain effect as compared to 1g OMF and 1g OMM fed group of albino rats. The highest weight gain was observed in 2g OMM dose, followed 2g OMF dose. Significant difference was found between
weight gain of control and experimental group. Overall rate of weight gain reflects that as dose increased, body weight also increased because of increase in protein intake.

Plasma total cholesterol was found to be significantly higher in control group than oyster mushroom doses fed group. Triglyceride level of control group (98mg/dl) was found more than all experimental groups. OMM doses showed better triglyceride lowering effect than OMF dose. It was observed that there was no change in vivo HDL-ch level of albino rats fed on control and experimental diets. On the other hand it was found that 2g OMM dose has LDL-ch lowering properties but was not observed in OMF doses. Two gram OMM supplementation reflects lowest LDL/HDL-ch ratio (0.72) which the atherogenic.

Effect of oyster mushroom doses on diabetic rats indicated maximum weight loss in control groups (20g) and minimum in 2g OMM fed group (10g), followed by 2g OMF (12g) group. The loss in body weight was significantly more in control group as compared to experimental group. Blood glucose level was found low in albino rats fed on 2g OMM dose, followed by 1g OMM and 10g OMF dose. Significant difference was found between control and experimental group in respect of hypoglycemic effect. Effect of mushroom doses on post meal blood glucose levels of diabetic control and experimental albino rats indicated (10g OMF and 2g OMM doses) excellent blood glucose lowering property. Mega doses were found more effective.

The actual costs of 1g OMF, 2g OMF, 5g OMF and 10g OMF are Rs.0.11, 0.22, 0.55 and Rs.1.10, respectively. One gram OMM showed 8.00 Rs. and 2g OMM is Rs.16. 1g OMF, 2g OMF, 5g OMF and 10g OMF doses contribute 0.33g, 0.66g, 1.65g and 3.30g protein, respectively. One gram OMM dose contribute 0.47g protein and 2g OMM dose contribute 0.94g. 2g OMM dose showed excellent therapeutic effect followed by 10g OMF and 1g OMM dose. The total scores indicated that 2g OMM showed higher in cost but excellent in therapeutic benefits. So the scores indicate that doses of OMM are beneficial for therapeutic application and the doses of OMF are good in nutritional contribution and lowest in cost.
5.2 Conclusion

Based on the objectives and results of the present research, following conclusions are drawn:

- Oyster mushroom fruiting and mycelium both are excellent source of protein. Mycelium is the most excellent source of plant protein.
- Oyster mushroom doses contain very low amount of fat but whatever fat is present, that is important for healthy heart.
- Carbohydrate present in mushroom is in the form of fungal cellulose. Carbohydrate of the mushrooms is not nutritionally important but most known for its medicinal factor, such as glucan, polysaccharide, chitin, etc.
- Oyster mushroom fruiting and mycelium contribute all essential amino acids. Phenylalanine, methionine, tryptophan, threonine, isoleucine, lysine and histidine values of mycelium found significantly more than fruiting.
- Oyster mushroom showed good sodium: potassium ratio, which is good for hypertension.
- Oyster mushroom mycelium is better source of calcium than fruiting. Oyster mushroom is a good source of phosphorus as well.
- Oyster mushroom contribute appreciable amount of iron and zinc. Copper and manganese are also present in appreciable amount, which are known for antioxidant activity.
- Growth experiment proved that the supplementation of oyster mushroom doses help to gain weight of albino rats because of its excellent nutritional composition.
- Mega doses of oyster mushroom give better lipid lowering effect than micro doses. This lowering effect may be due to presence of β-glucans, fibre, polysaccharide and chitin in oyster mushroom. It shows that consumption of oyster mushroom doses for long period of time will certainly protect from cardiovascular diseases.
- Oyster mushroom doses are effective in maintaining body weight of diabetic rats. Oyster mushroom doses showed significant hypoglycemic effect in allxan induced diabetic rats. Higher doses of oyster mushroom showed better results than lower doses. OMF and OMM both have blood glucose lowering effect. Mycelium doses found to be the most ideal for diabetics.
OMM doses showed excellent therapeutic effects and dose of OMF are good in nutritional contribution and cost benefit too. Mega doses of oyster mushroom mycelium are good in nutritional and therapeutic effect but are costly than fruiting doses. It can be made cost beneficial by adopting large scale production technology.

To sum up, it can be said that daily consumption of OMF doses are cost effect for normal as well as diabetics, heart patients in growing age. Nutritional and therapeutic benefits reveal that fruiting and mycelium are suitable for making nutraceuticals.

5.3 Implications

The probable usefulness of the findings of the present investigation for planning future course of research and development work is as follows:

5.3.1 Research implications
- Protein of oyster mushroom showed significant weight gain but parameter of identifying quality of proteins e.g. digestibility coefficient, net protein utilization, protein efficiency ratio are needed to be carried out.
- In the present study proximate composition, essential amino acids, nucleic acid and selected macro and micro minerals were estimated. Remaining minerals, essential fatty acids, vitamins and non-nutritional factors, which interfere in the absorption of nutrients in the body, these are needed to be analysed.
- Study was carried out for limited period but long term effect on nutrition and health need to be assessed.
- Study proposed that other medicinal effects like antibiotic activities (anti-fungal, anti-viral, anti-protozoal, anti-bacterial), anti-tumor, anti-cancer, anti-hypertension effect of oyster mushroom mycelium is a big area of research.
- Oyster mushroom doses need to be assessing for their antioxidant activity as well.
- Development of traditional and modern recipes out of fruiting of oyster mushroom is also an area of research.
- Development of dietary supplements, functional foods, designer foods, technofoods for human and animals is a thrust area of research.
- Doses of oyster mushroom mycelium need to be converted into nutraceutical form. Hence study on technology of conversion of doses into capsules or tablets are needed to be carried out.
- Number of nutraceuticals can be developed with other functional foods like whey protein, soyprotein, enzymes, and antioxidants.
- Large scale production technology of mycelium need to be developed for cost benefit.

5.3.2 Action implications
- Oyster mushroom is good in protein, vitamin and minerals, therefore consumption effect of nutraceutical develop out of oyster mushroom to overcome malnutrition in children, pregnant and lactating mother is needed to be carried out.
- Oyster mushroom doses are excellent source of micronutrients hence are good for making nutraceuticals to overcome micronutrient deficiencies.
- Oyster mushroom doses are low in energy, high in protein and micronutrients, therefore ideal for making nutraceuticals for obese and diabetics.
- Oyster mushroom doses are having good low calories, fibre, potassium/sodium ratio and has hypolipidemic effect. Hence are appropriate for making nutraceuticals for heart patients and for normal persons as well as a precautionary measure.
- Oyster mushroom is good in micronutrients, which are antioxidant, hence oyster mushroom nutraceuticals will help to protect from aging and chronic degenerative diseases.
- Dietary supplements and nutraceuticals out of oyster mushroom need to be developed for maintaining health of normal individuals.

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