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A note on functional properties of two edible wild mushrooms

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Abstract This study focused on the functional properties of two edible wild mushrooms *Auricularia auricula* and *Termitomyces umkowaan* occurring in the scrub jungles of southwest India. The least gelation capacity was lower in *A. auricula* than *T. umkowaan*. The water-absorption capacity was higher in *A. auricula* compared to *T. umkowaan*. The oil-absorption capacity was similar in both mushrooms. Foam capacity was high in cooked *A. auricula*, while it was opposite in *T. umkowaan*. Both mushrooms showed excellent foam stability. Uncooked and cooked samples of these mushrooms possess desired functional attributes, hence they could be employed in production of value-added food products. Owing tothe large quantities of fruit bodies occur in the scrub jungles during wet season, strategies to collect, process and preserve them for utilization as foodsource and quality food production need further attention.

Keywords: *Auricularia*, *Termitomyces*, Ethnic nutrition, Food security, Functional foods, Mushroom flour, Scrub jungles

Introduction

Edible wild mushrooms havebeen distributed worldwide and attracted the attention of nutritionists owing to their ethnic delicacy (Boa, 2004). Similar to legume seeds, edible mushrooms are rich source of proteins, essential amino acids, dietary fibre and carbohydrates (Sanmee *et al*., 2003). They are also known for vitamins and therapeutic potential to regulate the blood pressure, lowering the blood cholesterol, stimulation of immune system and quench the free radicals (Mattila *et al*., 2000; Sanmee *et al*., 2003; García-Lafuentea *et al*., 2010). The proximal components of food stuffs (proteins, carbohydrates, fibers, lipids and calorie) favorably transform depending on the conditions of processing (e.g. temperature, fermentation and fortification), which in turn modify the functional attributes of the food products (e.g. texture, flavor, foam and emulsion) (Panyam and Kilara, 1996; Greeshma *et al*., 2018). Thus, to

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improve theutility of edible mushrooms, suitable processing methods need to enhance the functional attributes appropriate for a specific food product.

The Western Ghats are well known for several wild edible mushrooms of nutritional and medicinal significance (Mohanan, 2011; Farook *et al*., 2013; Senthilarasu, 2014; Karun and Sridhar, 2014, 2017; Senthilarasu and Kumaresan, 2016). Similar to the Western Ghats, the scrub jungles of southwest India diverse in edible and ethnically-valued mushrooms (Karun and Sridhar, 2014; Greeshma *et al*., 2016; Pavithra *et al*., 2016). The present note aimed with preliminary assessment of functional properties of two common wild edible mushrooms occurring in the scrub jungles of southwest India.

Materials and methods

During the survey of mushrooms in the scrub jungles of southwest India from 2011 onwards (12°48'N, 74°55'E; 115 m asl), two edible wild mushrooms *Auricularia auricula* (L.) Underw. and *Termitomyces umkowaan* (Cooke & Massee) D.A. Reid were commonly occurring on the woody materials and termite mounds, respectively (Figure 1). They erupt in a large quantity and could be easily sampled, used for edible purpose and those could also be preserved. Fresh tender fruit bodies (~750–1,000 g fresh weight) were sampled during southwest monsoon (July-August, 2019) from three locations of scrub jungles as replicates and brought to the laboratory. Fruit bodies were rinsed in tap water followed by distilled water to remove the extraneous matter and blotted with blotting paper. Each replicate sample was divided into two parts. The first part was dried in a hot-air oven (55±2°C), while the second part was pressure-cooked with a slight amount of distilled water followed by oven drying (55±2°C). After attaining constant dry weight, the samples were milled and the flours were preserved in air-tight containers to assess functional properties.

Gelation

The method used by Coffman and Garcia (1977) was followed to determine the least gelation concentration in uncooked and cooked mushroom flours. Flour slurries were diluted (range, 2–20%) in distilled water in three replicates (w/v). Ten ml of each homogenized slurry concentrate was dispensed into test tubes and boiled in a water bath (1 hr) followed by cooling at 4°C (2 hr). The test tubes with mushroom gel were inverted and concentration at which the gel did not slip down was considered as the least gelation concentration.

Water-absorption

The water-absorption capacity of mushroom flours was determined by modified procedure by Beuchat (1977). The mushroom flour (1 g) in three replicates were transferred to graduated centrifuge tubes, vortexed with 10 ml distilled water and incubated at the laboratory temperature (27±2°C) for 30 min, centrifuged (5000 rpm) and the height of the supernatant was measured to express the water-absorbtion in ml per gram of flour.

Figure 1. Wild edible mushrooms: *Auricularia auricula* grown on wood log (a and b) and *Termitomyces umkowaan* procured from the termite mounds (c and d) of scrub jungles

Oil-absorption

The procedure by Beuchat (1977) was followed to assess the oil-absorption capacity of mushroom flours. To the mushroom flours (0.5 g) in graduated centrifuge tubes in three replicates, 5 ml edible oil (Sunrich Refined Sunflower Oil, Ruchi Soya Industries Ltd., Mumbai, India) was added and allowed to stand at the laboratory temperature (27±2°C) for 30 min. The incubated tubes were centrifuged at 5000 rpm for 30 min. The supernatant was measured to note the quantity of oil (in ml) absorbed per gram of flour.

Foam capacity

The foam capacity wasassessed by followingthemethod of Coffman and Garcia (1977). The mushroom flour (2 g) was mixed with 100 ml distilled water, transferred into a measuring jar and the total volume was noted. The whole contents in the measuring jar was transferred to a blender followed by vigorous whipping for 2 min and poured into a measuring jar and noted the volume including the foam to calculate the foam capacity.

$$\text{Foam capacity (\%)} = \left(\frac{\text{Volume after whipping in ml} - \text{Volume before whipping in ml}}{\text{Volume before whipping in ml}}\right) \times 100$$

Foam stability

The foam stability was evaluated by following the method of Coffman and Garcia (1977). Foam was produced from the mushroom flours as described to assess the foam capacity. The initial volume of foam was noted, the measuring jar with foam was kept aside without disturbance up to 8 hrat the laboratory temperature (27±2°C) and final foam volume was again noted to calculate the foam stability.

$$\text{Foam stability (\%)} = \left(\frac{\text{Final volume of foam after 8 hr in ml}}{\text{Initial volume of foam in ml}}\right) \times 100$$

Data analysis

Significance of functional properties (water-absorption capacity, oil-absorption capacity, foam capacity and foam stability) among uncooked and cooked samples of mushrooms were assessed by Student's *t*-test using Statistica Version # 8 (StatSoft Inc., 2008).

Results

Gelation

The least gelation concentration was lower in *A. auricula* compared to *T. umkowaan* (Figure 2). The cooked samples of *A. auricula* showed lesser concentration for gelation compared to uncooked samples, while cooking has not influenced the least gelation concentration of *T. umkowaan*.

Water-and oil-absorption

The water-absorption capacity was significantly higher in *A. auricula* compared to *T. umkowaan* (Figure 3a). In both mushrooms, cooked samples showed significantly higher water-absorption capacity than uncooked samples (p<0.05). The oil-absorption capacity was almost similar in uncooked as well as cooked samples of both mushrooms (Figure 3b). However, unlike in *A. auricula* it was significantly higher in cooked than uncooked samples of *T. umkowaan* (p<0.05).

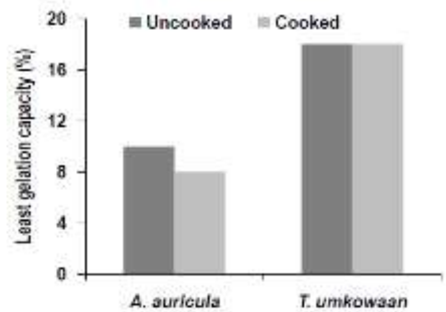

Figure 2. Least gelation concentration of flours of uncooked and cooked tender fruit bodies of *Auricularia auricula* and *Termitomyces umkowaan*

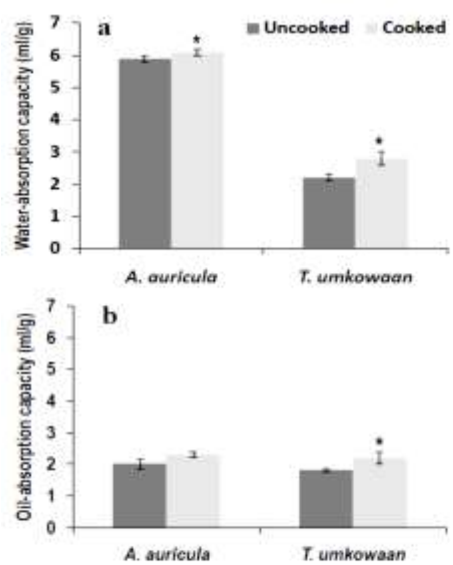

Figure 3. Water-absorption capacity (a) and oil-absorption capacity (b) of flours of uncooked and cooked tender fruit bodies of *Auriculari aauricula* and *Termitomyces umkowaan* (n=3 ±SD;*t*-test: *, p<0.05)

Foam capacityand stability

The foam capacity of cooked samples of *A. auricula* was higher than uncooked samples ($p<0.01$), while it was opposite in *T. umkowaan* ($p<0.05$) (Figure 4a). The foam stability was significantly higher in uncooked samples of both mushrooms ($p<0.001$) (Figure 4b)

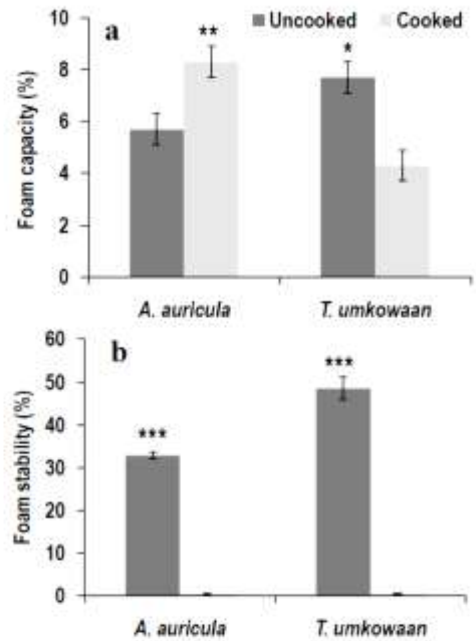

Figure 4. Foam capacity (a) and foam stability (b) of flours of uncooked and cooked tender fruit bodies of *Auricularia auricula* and *Termitomyces umkowaan* (n=3±SD; *t*-test: *, $p<0.05$; **, $p<0.01$; ***, $p<0.001$)

Discussion

Desired texture of the food stuff could be achieved by the meneuvering the gelation property of unprocessed or processed food material. It is governed by the protein content of the food stuff and advantageous to achieve gelation at low concentration (Akintayo *et al*., 2002). The least gelation concentration of *A. auricula* is lower compared to other edible wild mushrooms like *Amanita* sp. as well as *Astraeus hygrometricus* occurring in the scrub jungles of southwest India (8–10% vs. 14–20%) (Pavithra *et al*., 2017; Greeshma *et al*., 2018). The least gelation concentration of *T. umkowaan* is comparable with other edible wild mushrooms of the scrub jungle: *A. hygrometricus* (18% vs. 18–20%), while it was higher than *Amanita* sp. (18% vs. 14%). Interestingly, the crude protein content of *A. auricula*is lower than *T. umkowaan* (6.1–6.4% vs. 18.9–21.5%) (Karun *et al*., 2018), however, the least gelation concentration was lower in *A. auricula* than *T. umkowaan* indicates that the least gelation concentration may be dependent on the quality rather than the quantity of protein. The least gelation concentration in mixture of mushroom, wheat and tapioca attained as low as 2‒3% (Ekunseitan *et al*., 2016). In our study, without amendment of any flours, the least gelation concentration of *A. auricula* attained 8‒10%, which could be further decreased by mixing suitable cereal or mushroom flour especially with cooked *A. auricula* flour. The gelling capacity is known to hold water, flavor and sugars, thus the mushrooms studied help to to develop new products like semi-solid foodstuffs (Aremu *et al*., 2006; Appiah *et al*., 2011; Shad *et al*., 2011).

The water-absorption capacity is dependent on the contents of starch and fiber in mushrooms. The water-absorption capacity of *T. umkowaan* is comparable with other edible mushrooms like *Amanita* sp., *A. hygrometricus* and *Pleurotus sajor-caju* (2.2–2.8 ml/g vs. 1.8‒3.6 ml/g) (Prodhan *et al*., 2015; Pavithra *et al*., 2017; Greeshma *et al*., 2018). Similar to the *A. hygrometricus*, the *T. umkowaan* is useful in developing several food products like soups, dough and baked confectionaries (Pavithra *et al*., 2017). In our study, *A. auricula* absorbs high amount of water, thus the flour of this mushroom could be selected for the food stuffs needs higher water content especially ice-creams and gels.

The oil-absorption capacity of mushroom flours is dependent on the composition of amino acids, conformation of proteins and surface polarity (Chandra and Samsher, 2013). Such property adds flavor to the foodstuffs like doughnuts, sausages and meat formulations (Alobo, 2003; Chandra and Samsher, 2013). Thus, the oil-absorption capacity of *A. auricula* and *T. umkowaan* will be immensely valuable to produce baked products as well as soups.

The foam capacity of mushrooms studied is comparable to other edible mushrooms like *Amanita* sp. and *A. hygrometricus* (Pavithra *et al*., 2017; Greeshma *et al*., 2018). The extent of foam capacity of *A. auricula* and *T. umkowaan* will be useful to produce food formulations like cakes and ice-cream mixes (Niveditha and Sridhar, 2017). Owing to extremely high foam stability in uncooked *A. auricula* as well as *T. umkowaan*, this property could be used in production of food materials like desserts, cakes, toppings and mixes of ice-creams similar to edible *Amanita* sp. (Greeshma *et al*., 2018).

Overall, the wild edible mushrooms *A. auricula* and *T. umkowaan* occurring in scrub jungles of southwest India possess superior nutritional attributes, which control the functional properties such as gelation, water- / oil-absorption capacities, foam capacity and foam stability. Uncooked as well as cooked samples of these mushrooms posses desirable functional qualities to produce a variety of value-added foodstuffs. Fruit bodies of these mushrooms erupt in large quantities in scrub jungles during southwest monsoon season, thus they should be properly sampled, processed and preserved to produce different nutritionally versatile foodstuffs with enhanced nutraceutical attributes.

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