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RESEARCH ARTICLE

STUDY OF SOME FUNCTIONAL PROPERTIES OF EDIBLE WILD MUSHROOMFLOUROF *TERMITOMYCES LETESTUI* OF BOUAFLE (CÔTE D'IVOIRE)

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ABSTRACT

Termitomyces letestui is an edible wild mushroom that has little nutritional and biochemical potential. In order to highlight the nutrients contained in this mushroom and to contribute to its extension, the functional properties of the flour of the mushrooms *Termitomyces letestui* have been determined. Different methods were used and the results obtained among others are the following: water absorption capacity (WAC) 526.90 ± 2.55%; solubility index in water 40 ± 0.88%; apparent density 0.73 ± 0.01g / mL; porosity 40.57 ± 1.33%; wettability 52.75 ± 0.95 s; foaming capacity 15.52 ± 0.2%; dispersibility 48.75 ± 0.77%; Absorption capacity of refined palm oil 650.49 ± 0.7%; sunflower oil 652.91 ± 0.1%; palm oil 210.76 ± 0.02% and olive oil 656.16 ± 0.9%. At the hydrophilic-lipophilic ratio, the different values are: refined palm oil 0.81; sunflower oil 0.80; palm oil 2.50 and olive oil 0.80. All these functional properties of *Termitomyces letestui* mushroom's flour make it possible to say that it can be used in the food industry, in the formulation of compound flours used in bakery, pastry and infant feeding.

INTRODUCTION

Upper mushroom are defined as eukaryotic organisms devoid of chlorophyll, which explains their completely heterotrophic lifestyle (Bouchet *et al*., 1999). These are non-timber forest products (NTFPs) that were once considered foods with low nutritional value. For some time, these products have a proven nutritional and pharmaceutical interest. In fact, 80% of populations in developing countries use them either for food or for pharmaceutical purposes (Stanton, 2006). Mushrooms are consumed in many households. In rural areas where they are abundant, most people pick them up for their own consumption, as well as for extra income. These wild edible mushrooms are found in large quantities in the food markets. Despite the popularity of these mushrooms both in rural and urban areas, they have so far been little studied from a biochemical and nutritional point of view. The few existing studies have focused on morphological characterization, followed by identification (Avit, 1999) and the socio-economic aspect of fungi (Koné *et al.,* 2013). The objective of this study is to contribute to food security in Côte d'Ivoire through the valorization of wild edible mushroom through the study of some functional properties.

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MATERIAL AND METHODS

Material

The plant material used in this work is the *Termitomyces letestui* mushroom purchased from Bouaflé (Figure 1). A quantity of 800 g of fresh mushrooms was harvested by hands and then packaged in airy baskets and finally conveyed carefully to the laboratory.

Methods

Preparation of the mushroom flour: The mushrooms were first sorted and cleared of debris and foreign matter. Then they were rinsed with distilled water twice. Finally a mass of 500g was weighed. After display on aluminum foil at room temperature for 20 minutes, then dried in a MEMMERT ventilated oven at 45 ° C for 48 hours. After drying, the mushrooms were milled using a mill Mill IKA (Germany / Deutschland). The ground materials obtained were sieved using a 250 µm mesh screen. After sieving, the flours were packaged in labeled glass flasks, previously oven-dried at 45°C and sealed. These flasks were stored in a desiccators at 25 ° C for further analysis.

Water absorption capacity and solubility index in water: The water absorption capacity (WAC) and the solubility index in water (SIW) of the flour were determined according to the respective methods of Phillips *et al*. (1988) and Anderson *et al.* (1969). One (1) g of powder was dissolved in a centrifuge tube containing 10 ml of distilled water. This mixture was stirred for 30 min by a mechanical stirrer (AGIMATIC-N) and kept in a water bath at 37 ° C for 30 min. After centrifugation at 4200 rpm for 15 min in a centrifuge (SIGMA 3-16P), the pellet obtained (M_2) is weighed and then dried at 105 ° C. in a ventilated oven (MEMMERT) until obtaining a constant mass (M_1). WAC and SIW were calculated with the following mathematical formula:

$$WAC (\%) = (M_2 - M_1) \times 100 / M_1$$

M_1: dry mass of the sample after passage in the oven
M_2: mass of the fresh pellet after centrifugation

$$\mathbf{SIW (\%) = (M_0 - M_1) \times 100 / M_0}$$

M_0: mass of the sample taken

Oil absorption capacity: The oil absorption capacity (OAC) was determined according to the method of Sosulski (1962). One (1) g of flour was dissolved in 10 mL of oil. The mixture was stirred for 30 minutes at room temperature and then centrifuged at 4200 rpm for 15 minutes. The pellet recovered was weighed using a METLAR brand scale. The oil absorption capacity was calculated with the following formula:

$$OAC (\%) = (M_1 - M_0) \times 100 / M_0$$

M_0: mass of the sample taken
M_1: mass of the pellet

Hydrophilic-Lipophilic Ratio: The hydrophilic-lipophilic ratio (RHL) as defined by Njintang *et al.* (2001), was calculated as the ratio of water absorption capacity to oil absorption capacity. This ratio makes it possible to evaluate the comparative affinity of the powder for water and for oil.

$$HLR = SIW / WAC$$

Dispersibility: Thedispersibility (D) of the flour was determined according to the method described by Mora-Escobedo *et al*. (1991). Ten (10) ml of distilled water was added to 1 g of powder contained in a graduated 50 ml test tube. The mixture was stirred carefully by hand for 2 minutes (avoid losing part of the solution). The dispersibility of the flour was defined as the difference between the total volume (V_0) of the particles just after manually stirring and the volume (V_t) of the deposited particles recorded at time t min.

$$D (\%) = (V_0 - V_t) \times 100 / V_0$$

V_0: volume of the mixture just after stirring
V_t: volume of settled particles at time t

Apparent density (AD) and Porosity: The apparent density (AD) of the flour was determined according to the method of Narayana and Narasinga (1982). Fifty (50) g of flour (M_E) was placed in a 100 mL graduated cylinder. The volume (V_0) of this sample was noted after a good leveling with a spatula (without beating the sample on the bench). Then, the sample is gently tapped on the bench until a constant volume noted V_t.

$$AD (g/mL) = M_E / V_t$$

M_E: mass of sample taken
V_t: sample volume noted after fuss

Porosity (%) is determined according to the following formula:

$$P (\%) = (V_0 - V_t) \times 100 / V_0$$

V_0: sample volume noted after good leveling
V_t: sample volume noted after fuss

Wettability: The wettability of the flour was determined according to the technic of Onwuka (2005). One (1) g of powder was deposited in a graduated 25 mL test tube having a diameter of 1 cm. A finger was placed on the opening of the sample (to avoid pouring the sample by reversing it). The finger closing the test piece was placed at a height of 10 cm from the surface of a 600 mL beaker containing 500 ml of distilled water. The finger was removed and the sample is transferred to the beaker. Wettability was determined as the time required for the sample to become completely wet.

RESULTS

The analysis of the sample of the edible wild mushroom flour *Termitomyces letestui* allowed to determine some functional properties. The results obtained are shown in Figure 2 below.

Figure 1. Photography of some *Termitomyces letestui* mushrooms (Yoboue Guillaume Arthur K. L., 2015)

Figure 2: Some functional properties of the mushroom flour of *Termitomyces letestui*

Parameters	Contents
Water absorption capacity (%)	526.90±2.55
Solubility index in water (%)	40±0.88
Apparent density (g/mL)	0.73±0.01
Porosity (%)	40.57±1.33
Wettability (s)	52.75±0.95
Foaming capacity (%)	15.52±0.2
Dispersibility (%)	48.75±0.77
Oil absorption capacity (%)	
Refined palm (Dinor)	650.49±0.7
Sunflower	652.91±0.1
Palm	210.76±0.02
Olive	656.16±0.9
Hydrophilic-Lypophilic Ratio	
Refined palm (Dinor)	0.81
Sunflower	0.80
Palm	2.50
Olive	0.80

The water absorption capacity (WAC) is 526.90 ± 2.55%; the solubility index in water is 40 ± 0.88%; the apparent density is 0.73 ± 0.01 g / mL; the porosity is 40.57 ± 1.33%; the wettability of the powder is 52.75 ± 0.95 s; the foaming capacity is 15.52 ± 0.2%; the dispersibility value is 48.75 ± 0.77%. In addition, the absorption capacity of refined palm oil is 650.49 ± 0.7%; sunflower oil 652.91 ± 0.1%; palm oil 210.76 ± 0.02% and olive oil 656.16 ± 0.9%. At the hydrophilic-lipophilic ratio, the different values are: refined palm oil 0.81; sunflower oil 0.80; palm oil 2.50 and olive oil 0.80.

DISCUSSION

The water absorption capacity (WAC) is an index of the maximum amount of water that a food product would absorb and maintain (Marero *et al.,* 1988). It is important for some product characteristics, such as humidification of the product and starch retro gradation (Siddiq *et al.,* 2010). Thus, according to Otegbayo *et al.* (2013) previous studies of water absorption capacities of 265 and 380% were reported respectively for *Phaseoluslunatus* and *canavalisensiformis* seed meal and 275% for cowpea flour. This study showed that the water absorption capacity (WAC) of the flour of the mushrooms *Termitomyces letestui* is 526.90 ± 2.55%. According to Tyagi *et al.* (2007), the higher the WAC of flour is, the better the organoleptic characteristics are. In addition, Adebowale *et al.* (2005) found a WAC value of between 140 - 220% for Macuna flour suggested that it could be used for the formulation of baked goods and soups. The *Termitomyces letestui* flour could therefore be used for these same formulations. The solubility index in water (SIW) reflects the extent of starch degradation (*Mbofung et al.,* 2006). Our solubility index values (40 ± 0.88%) are higher than those obtained by Koh and Long (2012) on cassava flour (26.30%) and those reported on the starch of dried corn by Malumba (2008) who found a value of 13.9%.

Apparent density is affected by flour particle size and plays important roles during mixing (such as in dough formation), sorting, conditioning, and transporting food particles (Sakai, 1979). Apparent Density of *Termitomyces letestui* flour (0.73 g / mL) is lower than that obtained on pumpkin meal (2.97 g / mL) by Hamed *et al.* (2008), close to the one reported on the baked bread flour by Oulaï *et al.* (2014) who obtained a value of 0.61 g / mL and that of rice flour grown in Nigeria (0.65 to 0.79 g / mL) by Falade *et al.* (2014). Low apparent densities are desirable for the preparation of baby weaning foods (Jagannadham *et al.,* 2014). Nutritionally, low bulk density promotes food digestibility, particularly in children because of their immature digestive system (Nelson-Quartey *et al.,* 2008).
The Porosity of flour is a measure of the weight of the flour (Adejuyitan *et al.,* 2009). It determines the suitability of a flour to be easily packaged, which would facilitate the transport of a large amount of food (Shittu *et al.,* 2005). Nutritionally, high porosity favors the digestibility of food products, especially in children because of their immature digestive system (Nelson-Quartey *et al.,* 2008). The porosity of *Termitomyces letestui* mushroom flour is 40.57%. It is superior to that found on the taro bulb by Owuamanam *et al.* (2010) who obtained values of 31.8 to 33.2%. It is close to those of bread flours found by Tsatsaragkou *et al.* (2014) which are between 43.1 and 54.8%. The high porosity of the flour studied suggests that it could be useful in the formulation of infant food.

With regard to wettability, the study revealed that *Termitomyces letestui* mushroom's flour is 52.75 s. It is higher than that of soya flour (31 s) and is consistent with that of wheat flour (52 s) reported by Nwosu *et al.* (2014). Indeed, flour is said to be very wettable if the wettability time is less than 30 seconds; it is wettable if the time is less than 60 seconds. On the other hand, it is considered non-wettable if the wettability time is greater than 120 seconds (Pohl *et al.,* 2004). Thus, *Termitimyces letestui* flour is wettable and swellable because according to Schuck *et al.* (2007) flour capable of getting wet would be able to swell when handling pasta. Foaming capacity improves the texture, uniformity and appearance of food (Akubor, 2007). The foaming capacity of *Termitomyces letestui* flour is 15.52%. This value is higher than that of cassava flour (13.70%) (Ubbor and Akobundu, 2009). Dispersibility is the ability of flour to wet without lumping, with simultaneous disintegration of the agglomerates. This disintegration is achieved by breaking the bonds that keep the aggregates united in agglomerates (Otegbayo*andal.,* 2013). The value obtained for the *Termitomyces letestui* mushroom's flour is 48.75%.

This value is low compared to those obtained by Otegbayo *et al.* (2013) on the substitution of a portion of tapioca flour for soy flour (63 to 87%). Indeed the higher the percentage of dispersibility is, the more flour has a great capacity to replenish itself in water to give a fine and consistent paste (Kulkarni *et al.,* 1991). Oil Absorption Capacity is an important property in food formulation because the oil improves the flavor and gives a soft texture to the food (Aremu *et al.,* 2006). The refined oil absorption capacity offlour of the mushroom studied varies from 650.49% to 656.16%. These results are far superior to those reported by Adegunwa et al. (2011) (63 to 83%) and Medoua *et al.* (2005) (72.3 to 94.8%) in cassava flour, this suggests that refined oils (Dinor, Sunflower, Olive) have more attachment sites for this mushroom flour than cassava flour. On the other hand, the palm oil absorption capacity of the studied mushroom flour is 210.76% lower than that of palm oil studied by Fagbemi*and al.* (2006) on six varieties of taro (242 to 374%) and close to those obtained by Appiah *et al.* (2011) (150 to 250%). The hydrophilic - lipophilic ratio in refined oil (0.81) is close to that of Medoua *et al.* (2005) and Njintang *et al.* (2001) on cowpeas in the order of 1. This would mean that *Termitomyces letestui* mushroom flourhas much affinity for water than refined oil. That of palm oil is 2.48 higher than 1, which would mean that this flour has more affinity for water than red oil. Therefore, the flour treated with the refined oil should be preferentially intended for the formulation of products requiring a high water absorption capacity.

Conclusion

The study on the functional properties of *Termitomyces letestui* flour included water and oil absorption capacity, solubility index in water, foaming capacity, apparent density, porosity, wettability, hydrophilic-lipophilic ratio and dispersibility. It has revealed that this flour has a better water and oil absorption capacity, a good hydrophilic-lipophilic ratio and good porosity. In view of these properties, it would be interesting to this mushroom to be used in bakery, pastry and infant food. Moreover, the flour studied here has a good foaming capacity and a high apparent density, hence its possible use as a thickener in sauces and soups.

Also, it could be used as improving products resulting from emulsions and foams.

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