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RESEARCH ARTICLE

Preparation and physico-chemical characterization of mushroom juice

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ABSTRACT

The development of a novel food product: 'mushroom juice' using naturally occurring ingredients has been discussed in this work. The paste of button mushrooms of equal maturity was boiled with beet root extract, pomegranate juice, stevia and cinnamon powder in a specific formulation for juice preparation. Physical, chemical and rheological properties of the final strained juice were estimated using standard procedures. The juice had a pH and total soluble solids (TSS) of 5.03±0.07 and 7±1˚Brix respectively with a bright red colour (L*=87.18±3.00; b*=180.69±1.59; b*>a*). Protein, fat, sodium and potassium for the prepared juice were estimated as 7.99±0.13%, 0.7±0.1%, 0.002% and 0.067% respectively. The juice was also found microbiologically safe due to absence of coliform, yeast and mould. Investigation of rheological studies showed that the juice exhibits non-newtonian behaviour. The product developed in this work is expected to find easy marketability through practical applications in food industries.

Keywords: Button mushroom, mushroom juice, stevia, rheology

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INTRODUCTION

Mushrooms are edible fungi which can easily grow on plant residues and wastes. In practice, it is usually cultivated on compost. The cultivation of mushroom requires minimal land on contrary to other crops where huge expands of land is required. Button mushroom (*Agaricus bisporus* L.) is the most popular mushroom variety grown and consumed all over the world followed by shitake mushroom (*Lentinus edodes*) and oyster mushroom (*Pleurotus spp.*) (Sánchez, 2004). Mushrooms

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are a good source of minerals, amino acids (especially lysine and tryptophan), vitamins and antioxidants (Mattila et al., 2001; Mau et al., 2002; Liu et al., 2013). It has numerous medicinal properties (Jagadish et al., 2009) which aid in the prevention of chronic diseases such as hypertension, inflammation, liver problems and even cancer. It has a potential for export and is widely used as a food delicacy. According to ICAR-DMR, Solan, the total mushroom production in India is about 129,782 MT (Sharma, 2017). Mushrooms however, are susceptible to rapid enzymatic browning and microbial deterioration which causes major losses and wastage. Processing of mushrooms is therefore, essential for its extended availability and utilization. Mushrooms have been used in various forms in food products such as chips (Bora and Kawatra, 2014), jam, patties, biscuit (Wakchaure et al., 2010), powder and dehydrated cubes but the concept of developing a mushroom beverage remains unexplored. The development of such a beverage would be a novel approach to the utilization of mushrooms and will also provide easy access worldwide to the health benefits of mushrooms. Further, it may attract industries with an opportunity to manufacture a novel health-based food product for added financial profits. This work aims at developing a formulation for mushroom juice and estimating its physical, chemical and rheological properties.

MATERIALS AND METHODS

Sample procurement

Button mushroom (*Agaricus bisporus*) of identical size and maturity were cultivated and procured from Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar, India. The mushrooms were then washed to remove residual compost and were immediately processed for juice extraction. Stevia powder was obtained from Herb-Veda, Delhi.

Mushroom juice preparation

Mushroom sample of 250g was blanched at 100˚C for 3 min and immediately immersed in cold water at a temperature of 5±0.1˚C. The samples were then subjected to size reduction to obtain a suitable form for grinding. Grinding of samples was performed at 18000 rpm till it attained a pasty texture. The paste thus obtained was then transferred to 250 mL luke warm water (30-40˚C) and stirred to form a homogeneous solution. A combination of 200mL pre-prepared strained pomegranate juice and 10-12mL beet root extract was then added to the solution for imparting favourable colour. The mixture was then boiled at 100˚C for 3 min with constant stirring. To the boiling mixture, 50g stevia powder and 0.5g cinnamon powder was added for providing sweetness and anti-microbial properties respectively. The obtained juice was cooled to room temperature and strained through 2 layers of muslin cloth. The strained juice was filled in sterilized glass bottles and stored at 4˚C. The formulation of mushroom juice mentioned above was developed based on preliminary trials and sensory analysis (18 untrained panellists).

Estimation of physical and nutritional parameters

The prepared juice sample was analyzed for protein, fat, sodium and potassium using standard protocols as described in AOAC 2016. The pH and total soluble solid (TSS) of the juice was measured using a digital pH meter (Deluxe-101) and hand-held refractometer (Erma-Labline4) respectively. The colour (*L*, a*, b**) values of the juice were measured using a hand-held colorimeter. All measurements were carried out at 20˚C in triplicates. Chemical and reagents used were of analytical grade.

Microbiological analysis

Standard protocols for coliform count (IS: 5401; P-1), yeast and mould (IS: 5403) were followed for determination of microbial load in prepared mushroom juice.

Rheology

Non-newtonian fluids do not exhibit a direct proportionality between shear stress and shear rate. This rheological behaviour is described by various flow models. The most widely used among these models is the Ostwald-De-Waele equation, popularly known as the Power-law model given by Eq. 1. In this equation, τ is the shear stress, *dv/dr* is the shear rate, *k* is the consistency index and *n* is the flow behaviour index. For Newtonian fluids, *n* assumes the value of unity and *k* changes to η (viscosity). If for a particular fluid, information for the shear stress and shear rate is available, the values for *k* and *n* can be easily determined.

$$\tau = k\left(\frac{dv}{dr}\right)^{n} \quad (1)$$

The shear stress and shear rate values for freshly made mushroom juice were determined using a rheometer (MCR-52, Anton Par). A sample volume of juice was taken and passed through a layer of muslin cloth to remove any suspended particles. The measurements were performed on a DG 26.7 assembly with a SN33280 probe. The values of *k* and *n* were determined in MATLAB v.2012a by solving Eq. 1 using curve fitting tool.

RESULTS AND DISCUSSION

Physical characteristics

The total soluble solid of the prepared juice (Fig. 1) was obtained as 7±1˚Brix at 20˚C. This suggests that the juice falls under the ready to serve (RTS) category. Moreover, adding a natural sweetner: stevia, did not increase the TSS to a range unsuitable for diabetics. Since, sugars are the major components that contribute to TSS (Srivastava and Kumar, 2016), a lower TSS may indicate lesser glycemic index (GI) thereby, ensuring the health benefits of the prepared mushroom juice (Table 1).

Table 1: Physical characteristics of prepared mushroom juice

Physical characteristics	Corresponding Values
TSS	7±1˚Brix
pH	5.03±0.07
Standard color	
*L**	87.18±3.00
*a**	180.63±1.59
*b**	165.66±1.29

Figure 1. Prepared mushroom juice

The pH of the juice was measured as 5.03±0.07 which shows that the juice was slightly acidic in nature. The standard colour values of the juice in terms of *L*, a*, b** were obtained as 87.18±3.00, 180.63±1.59 and 165.66±1.29 respectively. Higher lightness values suggest more brightness of the juice. Positive *a** values on the higher end represents more redness of the juice which is due to the presence of betalin component of beet root.

Nutritional and microbiological characteristics

The nutritional property of the prepared mushroom juice was assessed on the basis of protein, fat and mineral (sodium and potassium) content. The determined composition has been showed in Table 2. Literature reports show that the protein content of button mushroom varies within 0.7-2% (Sadler 2003; Reis et al., 2012; and Tarafdar et al., 2017), however, the obtained protein value in mushroom juice exceeds the reported range. The increased protein content may have resulted due to the addition of beet root extract (Nemzer et al., 2011). The fat content of the juice was found to be slightly higher than reported studies (Sadler 2003 and Stamens 2005) which could also be attributed to the presence of other ingredients in the prepared mushroom juice. The sodium and potassium composition of the juice was observed to decline from the usual mineral content of fresh button mushrooms with greater decrease in potassium content. According to the findings of Kar et al., 2011, the sodium concentration in pomegranate juice is slightly higher than that of potassium. This could explain the lower variation of sodium as compared to potassium in the obtained juice. The coliform count, yeast and mould was not within detectable range for the bottled juice.

Table 2. Nutritional and Microbiological characteristics of mushroom juice

Parameter	**Protein**	**Fat**	**Sodium**	**Potassium**	**Coliform**	**Yeast**	**Mould**
Quantity/100g	7.99±0.13%	0.7±0.1%	0.002±0.000%	0.067±0.000%	ND	ND	ND

ND: Not Detectable

Rheological characteristics

The consistency (*k*) and flow behaviour index (*n*) was determined by plotting shear stress vs. shear rate in the curve fitting toolbox of MATLAB v.2012a (Fig. 2a). The algorithm used for the fit was Trust-region which was plotted within positive real number boundaries of the rheological parameters. The coefficient of determination for the fit was evaluated as R^2 = 0.946 with a RMSE of 5.3*E*-02. The corresponding value of *n* was calculated as 0.831 (n<1) which indicates that the fluid is pseudoplastic in nature. This suggests that mushroom juice exhibits a shear-thinning behaviour which is also evident from Fig. 2b. It is worthy to note that some abnormal dip in the curve for mushroom juice was found between the shear rates of 50-150 s^{-1}. This behaviour may be attributed to the presence of some particles which may be present after filtration. When these particles are hit by the rotating rheometer probe, a sudden increase in shear stress is recorded followed by a decrease due to clear liquid. This suggests that the rheological curve should actually be at slightly lower ranges of viscosity than that indicated in the plot of Fig. 2b. The consistency index for the juice was calculated as 7.3*E*-03 Pa.s. This value represents the non-newtonian viscosity of mushroom juice. Further, the obtained value is approximately 10 folds higher than the dynamic viscosity of water.

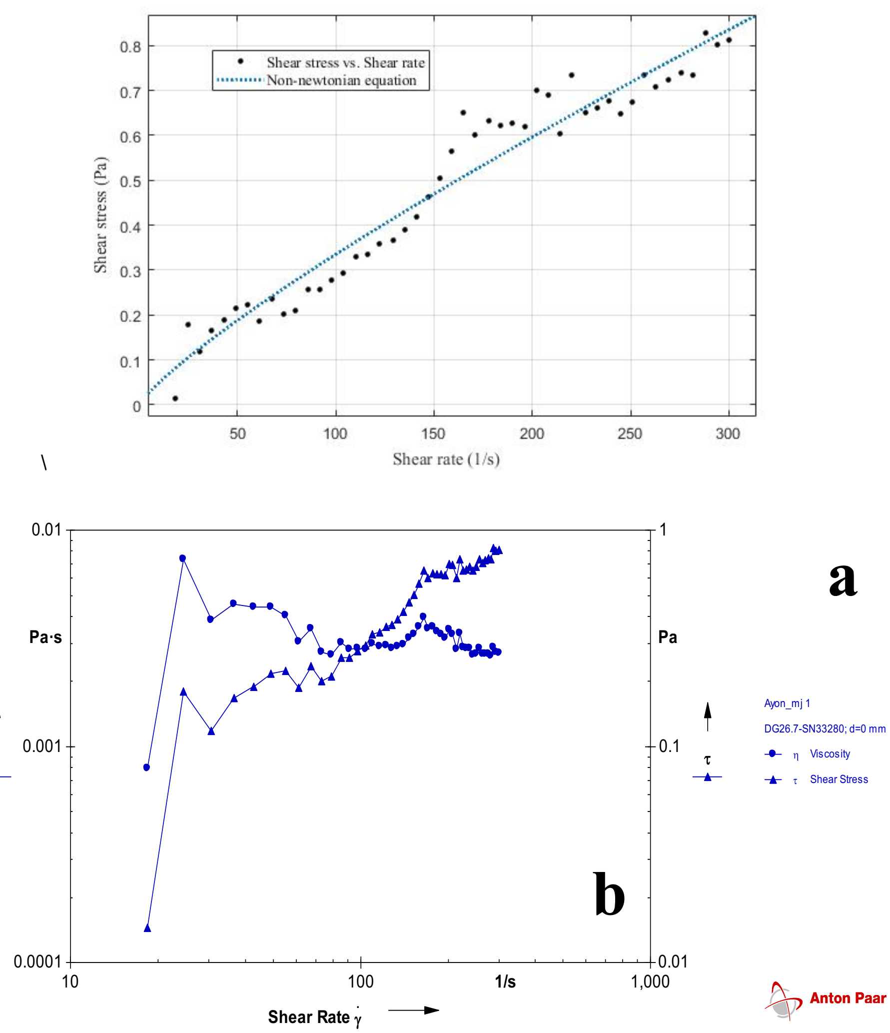

Figure 2: (a) Fit for Ostwald-De-Waele model to rheological data of mushroom juice. (b) Rheological behaviour of mushroom juice with increasing shear rate

CONCLUSION

The development of mushroom juice provides an innovative approach to prolong the availability of the nutritional and medicinal benefits of button mushrooms. The rapid rise in the demand for health based drinks encourages the development of such novel food products with enhanced nutritional and functional properties. The added ingredient in mushroom juice enhances its quality profile and thereby increases the marketability of the product. Considering the numerous benefits and simple and cost-effective production process, the juice should attract the attention of industries as well as consumers of various age groups.

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