INTERNATIONAL JOURNAL OF APPLIED BIOLOGY AND PHARMACEUTICAL TECHNOLOGY

www.ijabpt.com ISSN : 0976-4550

Volume-7, Issue-2, April-June-2016 Coden IJABFP-CAS-USA

Received: 4th Feb 2016 *Revised: 16th Mar 2016* *Accepted: 16th Mar 2016*

Research article

NUTRITIONAL, SENSORY AND MICROBIAL ATTRIBUTES OF READY TO USE SHIITAKE *(LENTINUS EDODUS)* MUSHROOM CURRY

Jyoti Singh and Sangeeta C. Sindhu

Department of Foods and Nutrition, COHS, CCSHAU, Hisar 125004, Haryana, India

ABSTRACT: The ready to use mushroom curry was prepared from treated and untreated mushroom pieces. Shiitake *(Lentinus Edodus)* mushroom was either solar dried following citric acid treatment or sun dried without any treatment. The mushroom pieces were rehydrated before curry preparation. The developed curries were evaluated for sensory and nutritional attributes and were stored for one month at room temperature. The stored curries were again evaluated for sensory qualities and total bacterial count. The developed curries were acceptable to judges and had a good nutritional profile with a protein content 8.99 ±0.17 to 9.12 ±0.09 g/100g, total carbohydrate 68.64±0.93 to 68.66±0.63g/100g, total fibre 14.58±0.30 to15.38±0.12 g/100g, soluble fibre 6.36±0.07 to 6.51±0.23g/100g, phosphorus content 507.69±0.33 to 508.35±0.02 and iron content 11.59±0.00 to 11.78±0.07mg/100g. The total bacterial count of curries varied from 0 to 18×10^2 cfu/g of product during 0 to 30th day of storage.

Key words: Nutritional evaluation, Sensory evaluation, Shiitake mushroom, Storage studies, Total bacterial count, Value addition

*Corresponding author: Sangeeta C. Sindhu, Department of Foods and Nutrition, COHS, CCSHAU, Hisar 125004, Haryana, India E-mail: chahalsangeeta@yahoo.com

INTRODUCTION

Mushroom cultivation is gaining popularity in India. Mushroom are mainly cultivated on the hills as it requires low temperature for its growth; however with the advent of modern cultivation technology it is now possible to cultivate mushroom seasonally under uncontrolled conditions and throughout the year by employing environmentally controlled conditions. Fresh mushroom is highly perishable and deteriorates immediately after harvest. Mushroom is a rich source of good quality protein, containing most of the essential amino acids, minerals and vitamins (Wang and Zhang, 2009). Shiitake is a major edible mushroom in Asia. Shiitake is likely to be the second favoured variety for use in different recipes after the common white mushroom. There are many reasons for gaining of popularity by Shiitake. When cooked, it imparts a full-bodied aromatic but distinctly pleasant flavor to the dish while maintaining its own original color and chewy texture. Fresh Shiitake resists both bruising and spoilage remarkably well. Lentinus edodes is the first medicinal macrofungus to enter the realm of modern biotechnology. Its popularity in the global market is attributed not only to its nutritional value but also to possible potential for therapeutic applications (Bisen *et al*., 2010). Mushrooms are rapidly perishable commodities, and they start deteriorating immediately within a day after harvest. In view of their highly perishable nature, the fresh mushrooms have to be processed to extend their shelf life for off-season use. Mushroom can be processed in many ways to extend their shelf life such as canning, drying, pickling, etc.

It is reported that drying is a comparatively cheap method and dried mushrooms, packed in airtight containers can have a shelf life of above one year. Pretreatments of mushrooms before drying in one form or other viz, washing in water, potassium metabisulphite (KMS), sugar, salt either alone or in combination are known to help in checking enzymatic browning, stabilizing colour, enhancing flavour retention and maintaining textural properties (Reyes *et al*.,2013; Izli and Isik, 2014; Jiang *et al*.,2015).

Present article summarizes the development of ready to use curry from treated and untreated dehydrated Shiitake mushroom and its nutritional, sensory and microbial attributes.

MATERIALS AND METHODS

All the ingredients were procured from open market in a single lot, cleaned and stored in air tight food grade container. Mushrooms were washed in running tap water and sliced before treatment. Mushrooms were divided into two lots. One lot was given pre drying treatment by dipping for 15 min in a solution containing 5 g/L Citric acid. The treated mushrooms were solar dried after that. Second lot was not given any pre drying treatment and was dried under open sun.

Development of curry

The ingredient were carefully and accurately weighted (Onion 250g, Garlic 5g, Ginger 2g, Salt 15g, Red chilli powder 15g, Curry powder 10g, Oil 20ml, Water 500ml). In a frying pan, oil was added and heated. Sliced onions were added to the oil and fried till golden brown. Garlic and ginger were ground into a paste, added and lightly fried till oil reappeared. Curry powder, salt and red chili powder were added and lightly fried. Water (500ml) was added to the spices mixture and boiled till thick consistency was obtained. This resulted in 450 g of cooked curry. Hundred grams of rehydrated mushrooms slices and 50 g of prepared curry were filled in the retort pouch. It was sterilized at 121^0C for 43 min and cooled rapidly **(NRCM-Process).**

Curry I contained no mushroom, Curry II contained untreated mushrooms while Curry III contained treated mushrooms.

Sensory Evaluation

Sensory evaluation of developed products was carried out according to 9 points hedonic scale (Ranganna, 1986) by a panel of ten semi trained judges. Each member evaluated the samples for colour, appearance, aroma, texture, taste and overall acceptability on a scale of 9 points.

Nutritional evaluation

The developed curries were analysed for Proximate composition (AOAC 2000), dietary fibre constituents (Furda, 1981), total carbohydrate (by addition method), total soluble sugars (Yemm and Willis, 1954), reducing sugars (Somogyi, 1945), non –reducing sugars (by difference) and starch (Clegg, 1956). *In vitro* protein digestibility was also determined (Mertz *et al*. 1983). Total iron, zinc, calcium and phosphorus in acid digested samples were determined by the atomic absorption spectrophotometer (Lindsey and Norwell, 1969). Mineral HCl extractability (Peterson, et al., 1943) and polyphenols (Singh and Jambunathan, 1981) were also studied.

Shelf Life Studies

Ready to use mushroom curries were stored at room temperature (30 ± 2°C) in retort pouches for one month and again subjected to sensory analysis at intervals of 15 and 30 days of storage.The fat acidity was determined by the standard method of analysis (AOAC, 2000).

The stored were also studied for microbial growth at storage intervals of 15 and 30 days. One gram of dried and powdered curry sample was dissolved into 9.0 ml of sterilized distiled water blank and shaken thoroughly. One ml of 10^{-1} dilution was taken and dissolved into 9.0 ml sterilized water blank. This was 10^{-2} dilution. Similarly 10^{-3} dilution was made. 0.1ml of 10^{-1}, 10^{-2} and 10^{-3} dilutions were poured in Petri plates containing PCA media. Plates were incubated at 30±2˚C for 24-48 hours. Numbers of colonies were counted and colony forming unit (cfu) was calculated by using formula:

No. of colonies × dilution factor × 10 = cfu /g of sample

Statistical analysis

Suitable standard statistical methods were used for analysis of data (Sheoran and Pannu, 1999).

RESULTS

The moisture content were 85.33, 86.47 and 86.66 per cent in curry I, curry II and curry III respectively (Table 1). The protein and fat content in curry I were 5.65 and 14.83 per cent respectively. Crude protein content of curry II and curry III were 9.12 and 8.99 per cent which were significantly ($P \leq 0.05$) higher than that of curry I. Crude fat were 14.98 per cent and 14.95 per cent in curry II and curry III respectively.

Total ash content were 0.62, 0.95 and 0.92 in curry I, curry II and curry III respectively. Crude fibre of curry I was 6.10 and it was 6.39 and 6.50 in curry II and III respectively. Curry II and III had significantly higher moisture content as compared to curry I. Also the total ash and crude fibre content of mushroom supplemented curries (curry I and II) were higher than that of curry I.

Total carbohydrate of curry I was 72.80 per cent, which was significantly ($P \leq 0.05$) lower in curry II (68.66%) and curry III (68.64%).Total soluble sugar of curry I was 19.98 per cent which was significantly ($P \leq 0.05$) lower than that of curry prepared from untreated and treated mushroom (22.96 and 20.14 respectively). There were no - significant ($P \leq 0.05$) differences in the reducing sugar content of all types of curry prepared. Non reducing sugar content of curry I (18.40%) was significantly ($P \leq 0.05$) lower than curry II (21.63%). No significant difference ($P \leq 0.05$) was observed in starch content of any developed curries. Total fibre, soluble and insoluble fibre were 14.30, 6.19 & 8.10 g/100g in curry I and 15.38, 6.36 and 9.02 g/100g in curry II. Curry III had 14.58, 6.51 and 8.07 g/100g total fibre, soluble and insoluble fibre respectively.

Curry I contained 182.12 mg/100g polyphenol content which was significantly higher than supplemented curries which contained 174.84 (curry II) and 171.03 mg/100g (curry III) polyphenol respectively. The polyphenol content of curry III was significantly ($P \leq 0.05$) lower than that of curry II also. *In vitro* protein digestibility was 50.68 per cent in curry I and it was significantly ($P \leq 0.05$) increased in curry II (57.56%) and curry III (60.18%). The *in vitro* protein digestibility of curry III was significantly ($P \leq 0.05$) higher than that of curry II as well (Table 1).

It was observed that the curry I contained 10.33, 7.26, 406.66 and 24.28 mg/100g iron, zinc, phosphorus and calcium respectively. Curry II (untreated mushroom supplemented curry) had significantly ($P \leq 0.05$) higher contents of all minerals than curry I. The contents were 11.59, 8.60, 507.69 and 29.59 mg/100g respectively. Curry III (treated mushroom supplemented curry) contained 11.78, 8.86, 508.35, 30.02 mg/100g iron, zinc, phosphorus and calcium respectively.

HCl extractability of iron, zinc, phosphorus and calcium of curry I were 32.25, 90.80, 48.73 and 51.30 respectively (Table 2). Extractability of iron, zinc and phosphorus were significantly ($P \leq 0.05$) higher (42.46, 93.83 and 50.33, per cent respectively, in curry II. Extractability of iron was significantly ($P \leq 0.05$) higher (44.13 mg/100g) in curry III compared to curry I and II. Zinc extractability was also significantly ($P \leq 0.05$) (96.85%) higher in curry III as compared to curry I and curry II. The extractability of phosphorus and calcium were significantly ($P \leq 0.05$) higher in curry III (53.33 and 53.60 respectively as compared to curry I and II.

Ready to use curry I had mean scores of colour 8.10, appearance 8.20, aroma 7.90, texture 8.10, taste 7.90 and overall acceptability 8.04 at day 0 (Table 3.). Mean organoleptic scores for curry III were 8.10 (colour), 8.10 (appearance), 8.00 (aroma), 8.10 (texture), 8.00 (taste) and 8.06 (overall acceptability) on day 0. No significant ($P \leq 0.05$) changes were observed in the 'colour' of curries after 30 days of storage. Organoleptic score for 'appearance' for curry II was significantly ($P \leq 0.05$) lower on days 15 and 30 as compared to day 0. The scores for 'aroma' for all three curries were reduced significantly ($P \leq 0.05$) on day 30 when compared to day 0 or 15. There were no significant ($P \leq 0.05$) changes in 'texture' acceptability scores of curry II and III after 30 days of storage. However it was significantly ($P \leq 0.05$) lower on day 30 as compared to day 15 or day 0 in case of curry I. For all the three curries the organoleptic score for 'taste' declined significantly ($P \leq 0.05$) after 30 days of storage (6.80, 6.70 and 6.30 for curry I, II and III respectively) as compared to day 15 or day 0. Overall acceptability of curry I on day 30 (6.97) was significantly ($P \leq 0.05$) lower as compared to its scores on day 15 (7.66) or day 0 (8.04). The overall acceptability scores for curry II declined significantly ($P \leq 0.05$) on day 15 (7.21) as compared to day 0 (7.70). The overall acceptability score of curry III on day 30 (7.02) was significantly ($P \leq 0.05$) lower than that on day 0 (8.06) (Table 3).

During storage, the fat acidity of curry ranged from 21.55 (0 day) to 24.12 (30 days) mg KOH/100g. The fat acidity of value added curry of untreated mushroom and treated mushroom ranged from 20.15 to 24.00 and 20.10 to 23.89 mg KOH/100g, respectively during 0 to 30 days of storage. There was a non-significant ($P \leq 0.05$) change in the fat acidity content of any of mushroom curry from 0 to 30 days of storage (Table 4).

The total bacterial count of curry I varied from 0 to 18×10^2 (cfu/g) of curry during 30 days of storage. The total bacterial count of curry II ranged from 0 to 15×10^2 cfu/g of curry while that of curry III ranged from 0 to 13×10^2 cfu/g of curry. The total bacterial counts of curries were within the acceptable range upto 15^{th} days of storage (Table 5).

Table 1. Nutritional composition of Ready to use Shiitake mushroom Curries

Component	Content			
	Curry I*	Curry II**	Curry III***	CD(P≤0.05)
Proximate composition (g/100g)				
Moisture	85.33±0.33[a]	86.47±0.26[b]	86.66±0.17[b]	0.32
Crude protein	5.65 ±0.10[a]	9.12 ±0.09[b]	8.99 ±0.17[b]	0.45
Crude Fat	14.83±0.03	14.98±0.03	14.95±0.06	NS
Total Ash	0.62±0.01[a]	0.95 ±0.00[b]	0.92±0.03[b]	0.07
Crude Fibre	6.10 ±0.55[a]	6.39 ±0.85[b]	6.50±0.01[b]	0.15
Carbohydrate composition(g/100g)				
Total Carbohydrate	72.80±0.54[a]	68.66±0.63[b]	68.64±0.93[b]	2.55
Total Soluble sugars	19.98±0.51[a]	22.96±0.03[b]	20.14±0.09[c]	1.06
Reducing sugar	1.58±0.29	1.33±0.33	1.40±0.29	NS
Non-Reducing Sugars	18.40±0.69[a]	21.63±0.31[b]	18.73±0.19[a]	1.60
Starch	28.18±1.32	25.22±2.69	25.01±0.69	NS
Dietary fibre constituents(g/100g)				
Total fibre	14.30±0.20[a]	15.38±0.12[b]	14.58±0.30[a]	0.78
Soluble fibre	6.19±0.31	6.36±0.07	6.51±0.23	NS
Insoluble fibre	8.10±0.45	9.02±0.07	8.07±0.27	NS
Antinutritional factor and *In vitro* protein digestibility (mg/100g)				
Polyphenol	182.12±0.28[a]	174.84±0.21[b]	171.03±0.54[c]	1.32
In vitro protein digestibility	50.68± 0.38[a]	57.56 ±0.84[b]	60.18 ±0.15[c]	1.91

Values are mean ± SE of three independent determinations

Curry I* = No mushroom added, Curry II** = Untreated mushroom, Curry III*** = Treated mushroom, Values with different superscripts differ significantly (P≤0.05) in respective row

Table 2. Mineral composition and their HCl extractability in Ready to use Shiitake mushroom Curries

Component	Content			
	Curry I*	Curry II**	Curry III***	CD(P≤0.05)
Mineral content (mg/100g)				
Iron	10.33±0.08[a]	11.59±0.00[b]	11.78±0.07[b]	0.22
Zinc	7.26±0.13[a]	8.60±0.09[b]	8.86±0.01[b]	0.27
Phosphorus	406.66±0.03[a]	507.69±0.33[b]	508.35±0.02[b]	0.68
Calcium	24.28 ±0.15[a]	29.59±0.08[b]	30.02±0.16[c]	0.50
HCl extractability (%)				
Iron	32.25±0.68[a]	42.46±0.28[b]	44.13±0.34[c]	1.67
Zinc	90.80±0.20[a]	93.83±1.16[b]	96.85±0.86[c]	2.98
Phosphorus	48.73±0.63[a]	50.33±0.33[b]	53.33±0.33[c]	1.61
Calcium	51.30±0.50[a]	51.49±0.59[a]	53.60±0.44[b]	1.82

Values are mean ± SE of three independent determinations

Curry I* = No mushroom added, Curry II** = Untreated mushroom, Curry III*** = Treated mushroom, Values with different superscripts differ significantly (P≤0.05) in respective row

Table 3. Sensory characteristics of Ready to use Shiitake mushroom curries after storage

Treatment	Storage period (days)			
	0	15	30	CD(P≤0.05)
Colour				
Curry I*	8.10±0.08	7.60±0.23	7.40±0.24	NS
Curry II**	7.60±0.16	7.00±0.33	7.40±0.20	NS
Curry III***	8.10±0.27	7.50±0.13	7.55±0.28	NS
Appearance				
Curry I*	8.20±0.12	7.90±0.21	7.20±0.21	NS
Curry II**	7.70±0.21^{a}	7.00±0.19^{b}	7.10±0.17^{b}	0.70
Curry III***	8.10±0.08	7.58±0.20	7.50±0.16	NS
Aroma				
Curry I*	7.90±0.18^{a}	7.70±0.10^{a}	6.70±0.15^{b}	0.60
Curry II**	7.70±0.14^{a}	7.50±0.15^{a}	6.50±0.16^{b}	0.54
Curry III***	8.00±0.12^{a}	7.50±0.15^{a}	6.40±0.16^{b}	0.59
Texture				
Curry I*	8.10±0.15^{a}	7.70±0.12^{a}	6.75±0.22^{b}	0.62
Curry II**	7.90±0.16	7.50±0.21	6.95±0.24	NS
Curry III***	8.10±0.10	7.80±0.15	7.65±0.23	NS
Taste				
Curry I*	7.90±0.20^{a}	7.40±0.21^{a}	6.80±0.23^{b}	0.58
Curry II**	7.60±0.09^{a}	7.45 ±0.09^{a}	6.70±0.18^{b}	0.64
Curry III***	8.00±0.15^{a}	7.15±0.18^{a}	6.30±0.15^{b}	0.85
Overall Acceptability				
Curry I*	8.04±0.13^{a}	7.66±0.20^{a}	6.97±0.21^{b}	0.46
Curry II**	7.70±0.15^{a}	7.21±0.09^{b}	6.93±0.18^{b}	0.38
Curry III***	8.06±0.13^{a}	7.51±0.13^{ab}	7.02±0.09^{b}	0.71

Values are mean ± SE of ten independent determinations

Curry I* = No mushroom added, Curry II** = Untreated mushroom, Curry III*** = Treated mushroom, Values with different superscripts differ significantly (P≤0.05) in respective raw

Table 4. Effect of storage period on fat acidity (mg KOH/100gm) of Ready to use Shiitake mushroom curries (on dry weight basis)

Treatment	Storage (days)			
	0	15	30	CD(P≤0.05)
Curry I*	21.55±1.27	23.22 ±1.55	24.12 ±1.30	3.57
Curry II**	20.15±0.71	23.10 ±0.67	24.00 ±0.82	4.64
Curry III***	20.10 ±0.88	22.00±0.87	23.89 ±0.92	2.64

Values are mean ± SE of three independent determinations

Curry I*= No mushroom, Curry II** = Untreated mushroom, Curry III*** = Treated mushroom

Table 5. Total bacterial count (cfu/g) of Ready to use Shiitake mushroom curries at different storage periods

Treatment	Storage period (days)		
	Total bacterial count (cfu/g)		
	0	15	30
Curry I*	0	8×10^{1}	18×10^{2}
Curry II**	0	6×10^{1}	15×10^{2}
Curry III***	0	5×10^{1}	13×10^{2}

Curry I*= No mushroom, Curry II** = Untreated mushroom, Curry III*** = Treated mushroom

DISCUSSION

All the developed products were acceptable to the panel of judges and had a good nutritional profile. Value addition with mushroom resulted in significantly ($p \leq 0.05$) higher protein, ash, soluble fibre and mineral content.. As the storage period increased, fat acidity also increased but the changes were non significant upto 30 days of storage.

The total bacterial counts of all mushroom curries were within the permissible limit for upto 15 days only. Similar work on product development, evaluation and shelf life has been reported by various other authors (Dwivedi, et al., 2005; Gupta, 2008; Rai and Arumuganathan, 2008; Dunkwal, et al., 2009; Kulshreshtha, 2009; Mishra, et al., 2011; Lakshmipathy, et al., 2013 and Bora and Kawatra, 2014).

CONCLUSION

It can be concluded that the Shiitake mushroom has a potential for use in food processing industry.

REFERENCES

AOAC. (2000). Official Methods of Analysis, 17th edition. Association of the Official Analytical Chemists, Washington D.C, USA.

Bisen, P. S., Baghel, R. K., Sanodiya, B. S., Thakur, G. S., & Prasad, G. B. K. S. (2010). Lentinus edodes: a macrofungus with pharmacological activities. Current Medicinal Chemistry, 17(22), 2419-2430.

Bora, P. and Kawatra, A. (2014). Study on nutritional evaluation and composition of oyster mushrooms (*Pleurotus florida*) . Food Sci. Res. J: Vol.5, 1, 56-58

Clegg, K.M. (1956). The application of anthrone reagent to the estimation of starch in cereals. J. Sci. Food Chem. Agric : Vol.7, 40-44

Dunkwal, V. (2006). Development and Nutritional evaluation of value added products using oyster mushroom (*Pleurotus caju*). Ph.D. Thesis, CCS Haryana Agriculture University, Hisar, India.

Dunkwal, V. and Jood, S. (2009). Effect of substrate on nutrient composition of oyster mushroom (*Pleurotus sajor caju).* J. Dairying, Food and Home science: Vol.26, 2, 132-136

Dwivedi, R., Shukla, P., Singh, G. and Bhattacharya, L. (2005). Development & quality evaluation of mushroom pickle, vegetable pickle and mixed mushroom vegetable pickle. Beverage & food world: Vol.10, 56-58

Furda, I. (1981). Simultaneous analysis of soluble and insoluble dietary fibre. In W.P.T. James, and O. Theander (Eds.). The Analysis of Dietary Fibre in Food. Marcel Dekker, New York, pp. 163-172.

Gupta, (2008). Nutritional evaluation shelf- life and utilization of tomato powder and puree. M.sc. thesis, CCS HAU, Hisar, India.

Hooda, S. (2002). Nutritional evaluation of fenugreek supplemented wheat products. M.sc. Thesis, CCS Haryana agricultural university, Hisar, India.

Izli, N., & Isik, E. (2014). Effect of different drying methods on drying characteristics, colour and microstructure properties of mushroom. Journal of Food & Nutrition Research, 53(2).

Jiang, N., Liu, C., Li, D., & Zhou, Y. (2015). Effect of blanching on the dielectric properties and microwave vacuum drying behavior of Agaricus bisporus slices. Innovative Food Science & Emerging Technologies, 30, 89-97.

Kulshreshtha, M., Singh, A. and Vipul, D. (2009). Effect of drying conditions on mushroom quality. Journal of Engineering Science and Technology: Vol. 4, 1, 90-98

Lakshmipathy, G., Arunkumar J., Abhilash, M., and Shantha, P.R. (2013). Studies on different drying, canning and value addition techniques for mushrooms (*Calocybe Indica*). African Journal of Food Science: Vol. 7, 10, 361-367, October 2013 DOI: 10.5897/AJFS2013.1002 ISSN 1996-0794©2013 Academic Journals http://www.academicjournals.org/AJFS

Lindsey, W.L. and Norwell, M.A. (1969). A new DPTA-TEA soil test for zinc and iron. Agron. Abst.: Vol.61, 84

Mertz, E.T., Kirleis, A.W. and Sxtell, J.D. (1983). *In vitro* digestibility of protein in major food cereals. Fed. Proc.: Vol.32, 5, 6026

Mishra, P., Verma, M., Mishra, V., Mishra, S. and Rai, G.K. (2011). Studies on development of ready to eat amla (*Emblica officinalis*) chutney and its preservation by using class one preservatives. American Journal of Food Technology: Vol.6, 244-252

NRCM (2005) - Annual Report – 2004-05. Published by National Research Centre for Mushroom, Solan, H.P, pp: 50-52.

Peterson, W.H. (1943). Elements of Food Biochemistry. Prentice Hall, Inc. New York, 73 p.

Rai, R.D., and Arumuganathan, T. (2008). Postharvest Technology of Mushrooms. National Research Centre for Mushroom. Chambagat, Solan-173 213, HP India, Pp1-10.

Ranganna, S. (1986). Manual of analysis of fruits & vegetable products. Tata Mc Graw Hills Publishing Company LTD., New Delhi.

Reyes, A., Mahn, A., Cubillos, F, & Huenulaf, P. (2013). Mushroom dehydration in a hybrid-solar dryer. Energy Conversion and Management, 70, 31-39.

Ritu, (2004). Development of value added products incorporating crude palm oil and its blends their sensory and Nutritional evaluation. M.sc. thesis, CCS HAU, Hisar, India.

Sheoran, O. P and Pannu, R. S. (1999). Statistical software package for agricultural research workers *In* Recent advances in information theory, Statistics and Computer application. Eds. Hooda DS and Hasija RC., pp. 139-143.

Singh, U. and Jambunathanan, R. (1981). Studies on *desi* and *kabuli* chickpea cultivars, levels of protease inhibitors, polyphenolic compounds and *in vitro* protein digestibility. J. Fd. Sci. : Vol.46**,** 1364-1367

Somogyi, M. (1945). A new reagent for the determination of sugar. J. Biol. Chem.: Vol.160, 60-61

Wang, X and Zhang, L. (2009). Physicochemical Properties and Antitumor Activities for Sulfated Derivatives of *Lentinan*. Carbohydrate Research: Vol.344, 2209-2216. http://dx.doi.org/10.1016/j.carres.2009.04.033

Yemm, E.W. and Willis, A.J. (1954). The estimation of carbohydrates in plant extracts by anthrone. Biochem. J.: Vol.57, 508-514

ISSN : 0976-4550

INTERNATIONAL JOURNAL OF APPLIED BIOLOGY AND PHARMACEUTICAL TECHNOLOGY

Email : editor.ijabpt@gmail.com

Website: www.ijabpt.com