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Studies on nutritional quality of mushroom powder cookies

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Abstract
The quality cookies were prepared from 12% mushroom powder and 88% wheat flour. The selected treatments were packed in LDPE and PP and stored at ambient (30 ± 4 ^{0}C) for 90 days to study their storage feasibility. Chemical composition of the fresh cookies prepared from 12% mushroom powder and 88% wheat flour showed that moisture content was 4.13% protein 14.45%, crude fat 17.22%, crude fiber 2.10%, carbohydrates 52.75%, calcium 47.10 mg/100 g, and iron 3,32 mg/ 100 g. The sensory evaluation of cookies was carried out regularly at an interval of 30 days for 3 months during storage. The results on overall acceptability score of cookies are influenced by storage. The results indicated that score for overall acceptability of cookies was decreased for control from 7.82 to 7.76 in LDPE and from 7.80 to 7.70 in PP as storage period get increased. For $CMWF_{12}$ treatment score decreased from 8.09 to 8.02 in LDPE and 8.08 to 8.00 in PP was observed for 90 days of storage. Storage study of cookies showed that the cookies prepared by incorporation of mushroom powder and wheat flour can be stored up to 3 months in LDPE with minimum losses in sensory, nutritional and textural characteristics than PP. There was no significant difference in crude fiber, calcium and iron content with advancement of storage period for 3 months. The cookies were found to be acceptable up to 3-month storage at ambient temperature. The total cost of production of cookies prepared from mushroom powder and wheat flour ($CMWF_{12}$) for 1 kg was Rs.180/.

Keywords: Mushroom powder, cookies, nutritional value, organoleptic properties

Introduction
The demand for health-conscious food for that reason the producer providing the health promoting food ever increasing due to the technological, industrial and economic advances of the developing societies of the world including India. The bakery industry has been rapidly growing in the country, being the largest among the processed food industries. The two major bakery industries namely bread and biscuits account for almost 82 per cent of the total bakery products. The annual production of bakery products is estimated to be more than 3.0 million tonnes (www.biscuitfederation.org). India is recognized to be the second largest producer of biscuits next only to the United States of America with annual production of which was 7.40 lakh metric tonnes in 1997-98 which has escalated to 20.14 lakh metric tonnes in 2010-2011 (Agrawal, 1990) [3]. Among the bakery products biscuits command wide popularity in rural as well as urban areas among people of all age groups (Agrawal, 1990) [3]. The production of biscuits in the country, both in the organized and unorganized sectors, is estimated to be around 11 million tones.

The cookie formula consists of refined flour, hydrogenated fat, sugar and other additives. It is well documented that most of the ingredients used in commercial cookies lack important nutrients. The refined flour lacks in dietary fiber and micronutrients which are important health promoting components. The hydrogenated fat comprises of trans-fats which have proven to be harmful to human health. Recognizing the negative health effects of trans fats many countries have banned the trans-fats in foods and have recommended zero tolerance to trans-fats in foods for infants and other vulnerable groups. Nutrition labelling to indicate the trans-fats content is made mandatory in many countries. There is a growing awareness among the consumers regarding the constituents that affect health both positively and negatively. The number of such health-conscious consumers is fast increasing and so is the health food industry. New foods with new health claims are flooding the market to meet the diverse demands of consumers. However, still there is ample scope to enhance the nutritional value of cookies both quantitatively and qualitatively using nutritious food ingredients. Protein as well as carbohydrates malnutrition is broadly perceived as, significant medical issue in the world due

to continuous diet of cereal-based food product. Improved the protein nature of the cereal-based diet by fortification. Edible mushroom is rich in protein, carbohydrate, minerals and other nutritive compounds. Fortification of mushroom in cookies helps improve cookies quality alongside fulfil the nutrition demand of people. Mushroom is now increasingly recognized that correct diet but also modulates and control many functions of human body and consequently contributes to the preservation of good health and the reduction of the danger of various diseases due antibacterial, antioxidant, antifungal and antiviral capabilities, contemporary pharmacological research verifies the mushroom's medicinal benefit. (Moore 1995) [18].

Materials and Methods Materials

Ingredients: The major ingredients for the preparation of products were mushroom (*Pleurotus sajor-caju*) was produced from All India Coordinated Research Project on Mushroom, College of Agriculture, Pune.

Wheat: Wheat variety NIAW – 3170 (Phule satvik) was procured from Wheat Research Station Niphad, Nashik.

Packaging material: The packaging material *viz*., LDPE and PP bags were procured from local market and used for packaging of cookies for storage study.

Treatment details: The mushroom cookies were prepared by using different level of mushroom powder and wheat flour shown below:

Table 1: Treatment details for preparation of mushroom powder cookies

Treatments	Wheat floure (%)	Mushroom powder (%)
T_0 (Control)	100	0
T_1	98	2
T_2	96	4
T_3	94	6
T_4	92	8
T_5	90	10
T_6	88	12
T_7	86	14
T_8	84	16
T_9	82	18
T_{10}	80	20

Method

Preparation of mushroom powder cookies

The cookies were prepared using standard levels of ingredients as per the traditional creaming process.

Hydrogenated vegetable fat and powdered sugar mixed thoroughly

↓

Wheat flour + mushroom powder + Sodium bicarbonate + ammonium bicarbonate

↓

Mix both the blends

↓

The dough will frame into a sheet and cut with impression cutter

↓

Kept for 2-3 min

↓

Baking at 180 ^{0}C for 12 minutes

↓

Cooling and Packaging

↓

Storage

Fig 1: Flow chart for preparation of mushroom powder cookies

Physical characteristics of raw material

The raw material wheat grains and mushroom were analyzed for different physical characteristics like thousand kernel weight, bulk density, true density and colour. Chemical properties of raw materials and cookies Chemical constituents like moisture, fat, protein, carbohydrate, crude fiber and minerals like calcium and iron content of raw material and cookies were determined as per the standard procedure.

Physico-chemical analysis of raw material cookies

The method described in A.O.A.C. (2000) [1, 2] for determining moisture was used. The protein content of cookies was estimated by determining total nitrogen content using standard Micro-Kjeldhal method and fat content of the cookies was estimated by the soxhlet method A.A.C.C (2000) [1, 2]. The crude fiber content in the products was estimated by A.A.A.C. (2000) [1]. The carbohydrate content in the selected cookies were obtained by subtracting from 100, the sum of values of moisture, protein and fat content per 100 g of the sample (Raghuramulu, *et al*., 1993) [22]. Calcium, phosphorous and iron were analyzed using atomic absorption spectrometry (AAS). These methods give a good precision and accuracy (Ojeka and Ayodele 1995) [20]

Packaging and storage of mushroom powder cookies

The selected treatments of mushroom powder cookies were packed in LDPE and PP and stored at ambient (30 ± 4 ^{0}C) for 3 months. The samples were drawn at an interval of 1 month and evaluated for chemical and sensory quality.

Sensory evaluation of cookies

Sensory evaluation of mushroom powder cookies was carried on 9-point hedonic scale. The average scores of the ten judges for different quality characteristics *viz*. colour and appearance, flavour, texture, taste and overall acceptability were recorded.

Statistical analysis

All experiments were carried out by using Factorial Completely Randomized Design (FCRD). The results obtained in the present investigation were analyzed for the statistical significance according to the procedure given by Rangaswamy (2010) [23]

Results and Discussion

Physical characteristics of raw materials

The results obtained for physical characteristics of mushroom powder are presented below:

Table 2: Physical characteristics of raw materials

Sr. No.	Physical Parameter	Mean Value
1	Colour	Dreamish white
2	Bulk density (kg/m^3)	0.51
3	True density (kg/m^3)	1.20
4	Porosity (%)	0.56

Each value represents the average of three determinations.

The mushroom powder colour was creamish white which indicated good quality. Data indicate true density, bulk density and porosity were 0.51 kg/m^3, 1.20 kg /m^3 and 0.56% respectively. The variations in density of mushroom may be due to random harvesting of mushroom at different maturity stages. This factor is important because it determines the capacity of storage, packaging and transport systems (Minjong *et al*, 2019) [16].

Chemical characters of raw materials

The results obtained for chemical characteristics of mushroom powder and wheat flour are presented here:

Table 3: Chemical characters of raw materials

Chemical constituent	Wheat	Mushroom powder
Moisture (%)	12.4	10.4
Protein (%)	10.98	14.13
Fat (%)	1.5	2.56
Crude fiber (%)	1.9	4.97
Carbohydrates (%)	69.8	58.12
Calcium (mg/100g)	41.09	48.4
Iron (mg/100g)	2.43	2.58

*Each value is the average of three determinations

Chemical characters of various raw materials are comparable with findings reported by Tosco, (2004) [32] Gopalan, *et al.*, (2006) [11]. Similar conclusions have been drawn by Bushway, *et al.*, (1981) [8] Mayela, *et al.*, (2007) [15] and Salazar, *et al.*, (2011) [26].

Sensory evaluations of fresh mushroom cookies

The organoleptic evaluation of cookies prepared by different combination of mushroom powder and wheat flour were carried out. Mushroom cookies were prepared and presented to panel of ten judges for assessing the quality and acceptability of product. Organoleptic evaluation of cookies was carried out using a 9-point hedonic scale of sensory characteristics such as colour, flavour texture, taste and overall acceptability. The score obtained for sensory evaluation for mushroom powder and wheat flour cookies are shown in Table 4. Mushroom powder and wheat flour cookies (12% mushroom powder: 88% wheat flour) were found the best for preparation of cookies and stored at ambient temperature (30 ± 4 ^{0}C) for 3 months.

Organoleptic quality parameters of a product assume pivotal role in anticipating the consumer response to the product (Rey 2006) [25]. Colour and appearance uniformity are vital components of visual quality of fresh as well as processed foods and play a major role in consumer choice (Alistair 2005) [4]. Flavour being a combination of taste, smell and mouth feel, has multifaceted impact on sensory quality of a product (Amerine, *et al.*, 1980) [5]. Overall acceptability of product is a function of various factors including colour and appearance, flavour, texture and taste. Amongst all samples for both cookies containing 12% mushroom powder and 88% wheat flour combination was found to be more acceptable. Singh *et al.*, (2000) [30] reported overall acceptability of product like cookies is a function of various factors including colour and appearance, flavour, texture and taste in the soy fortified biscuits storage. Gupta and Singh (2005) [12] reported overall acceptability of biscuits containing colour and appearance, flavour, texture and taste which gives overall acceptance by considering above all attributes.

Selection of Best Combination for Preparation mushroom powder Fortified Cookies

On the basis of organoleptic properties (colour and appearance, flavour, texture, taste and overall acceptability) the best combination from 12% mushroom powder 88% wheat flour was 12:88. For the storage study these combinations with control (100% wheat flour cookies) were selected and the cookies prepared from them were used for further storage study. During storage study their nutritional composition, organoleptic properties and microbial quality were analysed using standard procedures.

Table 4: Sensory evaluation of fresh Mushroom powder and wheat flour cookies*

Sample code	Sensory attributes*					
	Colour and appearance	Flavour	Texture	Taste	Overall Acceptability	Rank
$CMWF_0$	7.8	7.8	8.1	8.1	7.95	7
$CMWF_2$	7.9	8.0	7.9	8.2	8.00	6
$CMWF_4$	7.9	8.0	8.0	8.3	8.05	5
$CMWF_6$	8.0	8.2	8.3	8.3	8.25	4
$CMWF_8$	8.2	8.1	8.3	8.4	8.30	3
$CMWF_{10}$	8.4	8.3	8.4	8.4	8.42	2
$CMWF_{12}$	8.7	8.5	8.6	8.5	8.52	1
$CMWF_{14}$	7.0	6.6	6.9	6.8	6.80	8
$CMWF_{16}$	6.8	6.5	6.8	6.7	6.76	9
$CMWF_{18}$	6.6	6.3	6.5	6.2	6.45	10
$CMWF_{20}$	6.5	6.3	6.3	6.1	6.30	11
Mean	7.61	7.41	7.64	7.68	7.59	-
S.E. (M) ±	0.10	0.11	0.10	0.11	0.12	-
C.D at 5%	0.30	0.33	0.30	0.33	0.25	-

Maximum score out of 9. All results are mean value of ten determinations.

Where,

$CMWF_0$: 100% wheat flour: 0% mushroom powder
$CMWF_2$: 98% wheat flour: 2% mushroom powder
$CMWF_4$: 96% wheat flour: 4% mushroom powder
$CMWF_6$: 94% wheat flour: 6% mushroom powder
$CMWF_8$: 92% wheat Flour: 8% mushroom powder
$CMWF_{10}$: 90% wheat Flour: 10% mushroom powder
$CMWF_{12}$: 88% wheat flour: 12% mushroom powder
$CMWF_{14}$: 86% wheat flour: 14% mushroom powder
$CMWF_{16}$: 84% wheat flour: 16% mushroom powder
$CMWF_{18}$: 82% wheat flour: 18% mushroom powder
$CMWF_{20}$: 80% wheat flour: 20% mushroom powder

Nutritional value changes in mushroom cookies during storage

The average values of fresh cookies (100% wheat flour) were moisture increased for treatment $CMWF_0$ from 4.12 to 4.21 per cent in LDPE and 4.16 to 4.22 per cent in PP was observed for 90 days of the storage. The sample $CMWF_{12}$ showed increase in the moisture content 4.07 to 4.15 per cent in LDPE and 4.01 to 4.15 per cent in LDPE and 4.02 to 4.20 per cent in PP. Protein decreased for $CMWF_0$ treatment from 12.69 to 12.58 per cent in LDPE and from 12.65 to 11.45 per cent in PP was observed for 90 days of storage. The sample $CMWF_{12}$ showed from 14.52 to14.38 per cent in LDPE and from 14.49 to 14.33 per cent in PP. Fat decreased for treatment $CMWF_0$ from 23.65 to 23.50 per cent in LDPE and from 23.60 to 23.48 per cent in PP was observed for 90 days of storage. The sample $CMWF_{12}$ showed from 23.26 to 23.12 in LDPE and from 23.05 to 22.89 in PP. Crude fiber decreased for treatment $CMWF_0$ from 1.73 to 1.67 per cent in LDPE and from 1.70 to 1.64 per cent in PP was observed for 90 days of storage. The sample $CMWF_{12}$ showed crude fibre content 2.11 to 2.05 per cent in LDPE and from 2.09 to 2.05 per cent in PP. Carbohydrates decreased for $CMWF_0$ from 56.34 to 56.21 per cent LDPE and from 56.26 to 56.08 per cent in PP was observed for 90 days of storage. The sample $CMWF_{12}$ showed carbohydrate content 52.87 to 52.64 per cent in LDPE and from 52.84 to 52.61 per cent in PP. Calcium decreased for treatment $CMWF_0$ from 41.94 to 41.84 mg⁄100g in LDPE and from 41.92 to 41.84 mg⁄100g in PP was observed for 90 days. The sample $CMWF_{12}$ showed from

47.20 to 47.10 mg/100g in LDPE and from 47.19 to 47.08 mg/100g in PP. Iron decreased for treatment $CMWF_0$ from 2.52 to 2.40 mg/100g in LDPE and 2.50 to 2.37 mg/100g in PP was observed for 90 days. The sample $CMWF_{12}$ showed from 3.30 to 3.22 mg/100g in LDPE and from 3.26 to 3.18 mg/100g in PP (Table 5). Protein, fat, crude fiber, carbohydrate, calcium and iron decreased in ambient temperature during storage period of 3 month. The decrease in moisture, protein, fat, carbohydrate, crude fiber, calcium and iron were more rapid in the samples stored in PP than LDPE during the storage period.

Table 5: Nutritional changes in mushroom powder cookies during storage at ambient temperature

Parameter	Moisture (%)	Protein (%)	Fat (%)	Crude fibre (%)	Carbohydrate (%)	Calcium (mg/100 g)	Iron (mg/ 100 g)
Treatment							
T_0: $CMWF_0$	4.17	12.58	23.56	1.68	56.19	41.89	2.44
T_1: $CMWF_{12}$	4.13	14.43	23.07	2.07	52.72	47.14	3.23
S.E.(M) +	0.005	0.005	0.007	0.00	0.007	0.005	0.00
CD at 5%	0.01	0.0013	0.021	0.0014	0.020	0.014	0.013
Packaging material							
P_0: Low Density Polyethylene	4.14	13.54	23.38	1.89	54.50	44.53	2.85
P_1: Polypropylene	4.17	13.47	23.25	1.86	54.41	44.51	2.82
S.E. (M) +	0.005	0.005	0.007	0.005	0.007	0.005	0.005
CD at 5%	0.01	0.013	0.021	0.0014	0.026	0.016	0.016
Storage period							
C_1: 30 days	4.12	13.58	23.39	1.90	54.58	44.56	2.89
C_2: 60 days	4.15	13.51	23.31	1.87	54.43	44.53	2.83
C_3: 90 days	4.19	13.42	23.24	1.84	54.36	44.46	7.79
S.E. (M) +	0.006	0.006	0.009	0.00	0.008	0.007	0.007
CD at 5%	0.018	0.016	0.025	0.00	0.024	0.019	0.019
Interaction							
$T_0P_0C_1$	4.12	12.69	23.65	1.73	56.34	41.95	2.52
$T_0P_0C_2$	4.16	12.60	23.59	1.70	56.25	41.92	2.45
$T_0P_0C_3$	4.22	12.58	23.50	1.67	56.21	41.85	2.40
$T_0P_1C_1$	4.16	12.65	23.60	1.70	56.26	41.93	2.50
$T_0P_1C_2$	4.18	12.56	23.56	1.66	56.12	41.89	2.42
$T_0P_1C_3$	4.21	12.45	23.48	1.64	56.08	41.84	2.37
$T_1P_0C_1$	4.01	14.52	23.26	2.11	52.87	47.20	3.30
$T_1P_0C_2$	4.12	14.48	23.16	2.08	52.78	47.17	3.26
$T_1P_0C_3$	4.15	14.38	23.12	2.05	52.64	47.10	3.22
$T_1P_1C_1$	4.02	14.49	23.05	2.09	52.84	47.19	3.26
$T_1P_1C_2$	4.16	14.41	22.95	2.07	52.75	47.15	3.21
$T_1P_1C_3$	4.20	14.33	22.89	2.02	52.61	47.08	3.18
S.E. (M) +	0.012	0.11	0.017	0.00	0.16	0.013	0.01
CD at 5%	0.034	0.033	0.049	NS	0.47	NS	NS

All results are mean value of three replication.
Where, $CMWF_0$: Cookies with 100% wheat flour and 0% mushroom powder.
$CMWF_{12}$: Cookies with 88% wheat flour and 12% mushroom powder.

Mirsaeedghazi, *et al. (*2008) [17] reported that increase of protein in dough causes greater consistency of dough. The interaction including physical and chemical forces among protein molecules play key role on the rheological properties (Shiau and Yeh, 2001) [29].The increase in protein content is acceptable for better rheological characteristics. According to Singh (2000) [30] during the processing and storage of foods, various flour proteins found in wheat and sweet potato can undergo changes in protein cross-linking, protein-carbohydrate interactions, and protein denaturation due to non-enzymatic reactions which affect food deterioration and shorten shelf life. Protein alterations in cookies may arise as a result of interactions between reducing sugars and amino acids during storage (Maillard reaction).

According to Jideani and Akingbala (1993) [13] increasing the amount of mushroom powder in the biscuit improved the moisture content by 4.5 to 6.5 per cent. Because protein has been shown to have a strong affinity for moisture, the increased moisture content in biscuits can be linked to the rise in protein content with the addition of mushroom powder.

In cookies production, addition of fat imparts tenderness making it more palatable; assist in texture improvements. External added fat during preparation of cookies have plasticizing effects reported by Mulvancey and Cohen (1997) [19]. Sharoon, *et al.,* (2014) [28] reported considerable increment the moisture content in all cookies with increasing storage duration. This increase was primarily due to packaging material (polythene bags). The packaging was not airtight, and lack of temperature control resulted in an increase in moisture contents of cookies. Moreover, cookies absorbed moisture from surrounding atmosphere due to hygroscopic behavior of wheat flour. An increase in moisture contents of cookie samples during storage has also been reported by Leelavathi and Rao (1993) [14], Rao, *et al.,* (1995) [24] Pasha, *et al.,* (2002) [21], Butt, *et al.,* (2004) [9] and Shariff, *et al.,* (2005) [27] either due to atmosphere or packaging materials.

Conclusion

These results indicates that $CMWF_{12}$ cookies (12% per cent mushroom powder and 88% wheat flour) with constant levels of other ingredients *viz*. sugar 50g, vanspati ghee 50g, sodium

bicarbonate 1g, ammonium bicarbonate 1g and water 20 ml respectively. Stored at ambient temperature had better acceptability till 90th day. It is evident from all the physico-chemical properties that $CMWF_{12}$ cookies (88 per cent mushroom powder and 88 per cent wheat flour are the best in LDPE than PP for preparation of mushroom cookies of good quality.

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