PRODUCTION OF YOGHURT FORTIFIED WITH MUSHROOM

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Abstract

Yoghurt was made from buffalo milk (3.5% fat) fortified with mushroom powder. Mushroom was used in two forms (cap and steak) at levels of 0.5 and 1% either cap or steak. Control was made from buffalo milk free from mushroom. The chemical composition, rheological properties and sensory properties of yoghurt were evaluated when fresh and during storage period at 5±2°C up to 12 days. Adding mushroom increased total solids, fat, total protein, ash and carbohydrates contents. TS, fat, total protein, ash contents and titratable acidity of all treatments were increased while the carbohydrates content and pH values decreased gradually during storage period. The treatments containing mushroom were slightly significant higher in whey off and penetration than control. Results indicated that fortification of buffalo milk with mushroom caused a decrease in acetaldehyde and diacetyl contents of treatments. Organoleptic evaluation scores of yoghurt treatment made with 0.5% (mushroom cap powder) (MCP) was higher than control and other treatments. It may be concluded that, addition of mushroom to buffalo milk could be achieved successfully in yogurt making.

INTRODUCTION

In recent years, there is an increase in the consumption of dairy products especially fermented dairy products. This is primarily explained by the diversity of products available and their healthy action. Yoghurt and other fermented dairy products made by fermentation of milk using a mixed culture of thermophilic Lactic acid bacteria (*Lactobacillus bulgaricus* and *Streptococcus thermophilus*).

Other dairy or non dairy ingredients may be added to the yoghurt. Mushroom was suggested in this study for several benefits. Mushroom has long been valued as delicious and nutritional food in many countries. Mushroom is appreciated, not only for texture and flavor but also for its chemical and nutritional properties (Manzie *et al.*, 1999 and Diyabalanage, 2008). On dry weight basis, mushroom can be considered to be a good sources of digestible proteins (10-40 %), carbohydrates (3-21 %) and dietary amino acid contents 34-39 %. The essential amino acids, cysteine and methionine are limited amino acids in mushroom.

Although mushroom contains all the main fractions of lipids, including free fatty acids, mono, di-and tri-glycerides, sterol esters and phospholipids, their levels are low,

approximately 2-8 % (on dry weight basis). Oleic and linoleic acids accounted for 72-77 % of the total fat in mushroom (Longvah & Deosthale, 1998). The calorific value of most mushroom is also low. Mushroom is excellent source of thiamine (vit. B_1), riboflavin (vit. B_2), nicotinic acid (vit. B_3), biotin and ascorbic acid (vit. C). mushroom is not only source of nutrients but has also been reported as therapeutic foods, useful in preventing diseases such as hypertension, hypercholesterolemia and cancer, whereas it contains interesting functional components such as B-glucans at a concentration ranging from 0.21 to 0.53 g /100 g on a dry basis (Manzi and Pizzoferrato, 2000 and Mallavadhani, 2006). Some isolated and identified compounds, originating from mushroom, show other quite significant medical properties, other than immunomodulatory activity, such as cardiovascular, liver protective, anti-fibrotic, anti-inflammatory, anti-diabetic, anti-viral and antimicrobial activities (Ooi and Liu, 1999, Ooi, 2000). Very limited studies have been carried out on mushroom fortification of different dairy products. For example, Fayed *et al.*, (2009) manufactured processed Ras cheese spread with mushroom powder.

The aim of the present work was to evaluate the possibility of making good quality yoghurt fortified with mushroom, and study the effect of fortification on chemical, rheological and sensory properties of yoghurt.

MATERIALS AND METHODS

Materials

Fresh buffaloe's milk was obtained from Dairy Dep., Faculty of Agriculture, Cairo University, Egypt. Freshly common (button) mushroom (*Agaricus bisporus*) fruiting body was obtained from Research and production unit of mushroom. Agriculture Research Cernter, Giza, Egypt. Pure culture of *Str. salivarius sub sp. thermophilus* and *Lactobacillus delbrueckii subsp. bulgaricus* TCC were obtained from Hansen Laboratory, Demark.

Methods

Drying and powdering of mushroom fruiting body

Mushroom fruiting body was cleaned, cut into slices, dried in an oven at 65°C for 48h, as described by Buwjoom et al., (2004), and finely powdered. The resultant mushroom powder was 95.8 dry matter. While chemical composition for fruiting body in dry matter (total nitrogen 5.20, fat 1.9, fiber 8.1 and ash 8 respectively).

Preparation of yoghurt

Fresh buffalo's milk was heated at 90°C for 10 min., after standardized to (3.5±0.2% fat) immediately cooled to 40°C added mushroom ratio 0.5, 1 % mushroom cap and 0.5, 1% mushroom steak to milk. Active starter (2% w/w) was

added and mixed. The inoculated milk was packed in plastic cup. The cups incubated at 40±1°C for 2-3 hr. (3 replicates) then were transferred into the refrigerator. The resultant yoghurt was stored in the refrigerator and sampled when fresh and every 4 days up to 12 days during storage in refrigerator (5±2°C).

Chemical analysis

Yoghurt treatments were analyzed for total solids (T.S%) fat (%). Total protein (%), ash content (%), titratable acidity (TA%) and pH value according to the methods of A.O.AC (1995), carbohydrate content was calculated by difference. The acetaldehyde content was measured according to the method described by Bradley et al., (1992)

Rheological properties

Synersis and firmness which are considered the most important rheological properties of the yoghurt were measured according to the method described by Abd-El-Salam et al. (1991) and Ahmed (1997) respectively.

Sensory evaluation

Flavour, appearance, body and texture (included color, wheying off, firmness and smoothness) were organoleptically evaluated by well trained ten panelists. Each property was given a score of 10 according to El-Etriby et al., (1997).

Statistical analysis

Statistical analysis were carried out by SPSSIO (SPSS, Chicago, 111) program for windows. The level of statistical significance was set at $P < 0.05$ as reported by (Eid *et al.*, 2001).

RESULTS AND DISCUSSION

Chemical composition

Chemical composition of yoghurt as affected by using different levels of mushroom either cap or steak forms is presented in Table (1). The total solids (TS) of the resultant fresh yoghurt untreated and treated with mushroom ranged from 14.04 to 15.26%. The data also, indicated that addition of mushroom significantly increased ($P \leq 0.05$) of total solids content of all treatments. TS contents were increased with increasing the percentage of mushroom added in the buffalo milk either cap or steak forms. Slight increases were found in TS contents as a result of cold storage in all treatments including control. This may be associated with some dehydration during storage. These results are in agreement with those reported by (El-Etriby et al., 1997). Also in table (1) , the yoghurt treatments made with mushroom steak powder (MSP) had significantly higher fat, total protein and ash contents than corresponding treatments those made with mushroom cap powder (MCP) and control. These

contents (fat, total protein ad ash) increased with increasing the ratio of mushroom either cap or steak forms. The fat, total protein and ash contents in all treatments including control increased gradually during storage period and this increase could be attributed probably to due to increasing of total solids. The obtained data were in agreement with those of Abd El-Rahman and Salama (2008). From the data in Table (1), it could be also seen that, yoghurt with 0.5% mushroom cap powder (MCP) had the highest carbohydrates content while yoghurt control had the lowest. The carbohydrates content of yoghurt decreased gradually in all treatments including control during storage period. This decrease in carbohydrates content may be attributed to fermentation of lactose by lactic acid bacteria (Dirar, 1993). The difference in carbohydrates contents of treatments during storage are significant.

Fig. (1) illustrates the changes in titratable acidity and pH values of yoghurt as affected by adding mushroom either cap or steak forms in buffalo milk. It is obvious that, adding mushroom to buffalo milk led to a significant increase in titratable acidity of resultanting yoghurt. This increase related to higher carbohydrates content in treated yoghurt. Among treatments, treatment with 1% (MSP) had the highest titratable acidity, while yoghurt control contained the lowest. There were slight significant increase ($P \leq 0.05$) in titratable acidity for all treatments made from mushroom including control as the storage period advances. These results are in agreement with those reported by Ayar et al., (2005). The trend of change in pH values of yoghurt of all treatments were opposite to that found for the titratable acidity.

Rheological properties

Data given in (Table 2) show the effect of fortification of buffalo milk with mushroom either cap or steak on penetrometer reading of resultant yoghurt. The penetrometer readings are inversely related to firmness. Results indicated that the fortification with mushroom caused significant decrease ($P \leq 0.05$) in firmness of all yoghurt treatments compared with control. This decrease may be related to the higher carbohydrates in treated yoghurt, which have a high water binding capacity. Firmness of all yoghurt batches made from buffalo milk without mushroom or with mushroom gradually decreased ($P \leq 0.05$) as storage period progressed.

Data listed in Table (2) revealed that synersis values of slight significance increased by adding mushroom to milk of yoghurt compared with increasing amount added of mushroom either cap or steak. The synersis values for the samples including control decreased by storage.

The acetaldehyde and diactetyl contents of yoghurt as affected by using different levels of mushroom either cap or steak forms is shown in fig (2). Results

indicated that fortification of buffalo milk with mushroom caused a decrease in acetaldehyde and diacetyl contents of treatments, this decrease was proportional to the amount of mushroom either cap or steak added. In general, the levels of acetaldehyde of all treatments including control exhibited opposite trend as that of diacetyl content. At the end of storage period, the acetaldehyde and diacetyl contents were decreased in all treatments including control. This decrease may be attributed to decrease in carbonic compounds in yoghurt by the end of the storage period (Tamime and Robinson, 1997).

Organoleptic evaluation

Organoleptic evaluation scores of yoghurt as affected by adding mushroom to buffalo milk when fresh and during storage at 5±2°C are given in Table (3). Results indicated that, treatment (T_2) scored the highest while lowest score was gained by treatment (T_5). Use of mushroom especially the lower percentages were significantly improving the quality of resultant yoghurt. Fresh yoghurt exhibited nearly flavour and body and texture while the appearance was less differed in various treatment. Body of yoghurt exhibited more softness with adding MCP from MSP in buffalo milk. All yoghurt were sensory acceptable but the best yoghurt resulted by adding mushroom cap powder (MCP) in ratio 0.5% to buffalo milk. From Table (3), it could be also seen that, the sensory quality of all yoghurt were gradually decreased (significant at $P \leq 0.05$) during storage period. Similar trends were obtained by Abd El-Rhman and Salama (2008).

It could be generally concluded from those results that, addition of mushroom is significantly successful and contributing the quality of resultant yoghurt and the best quality yoghurt was obtained by adding 0.5%of mushroom cap powder (MCP) to buffalo milk.

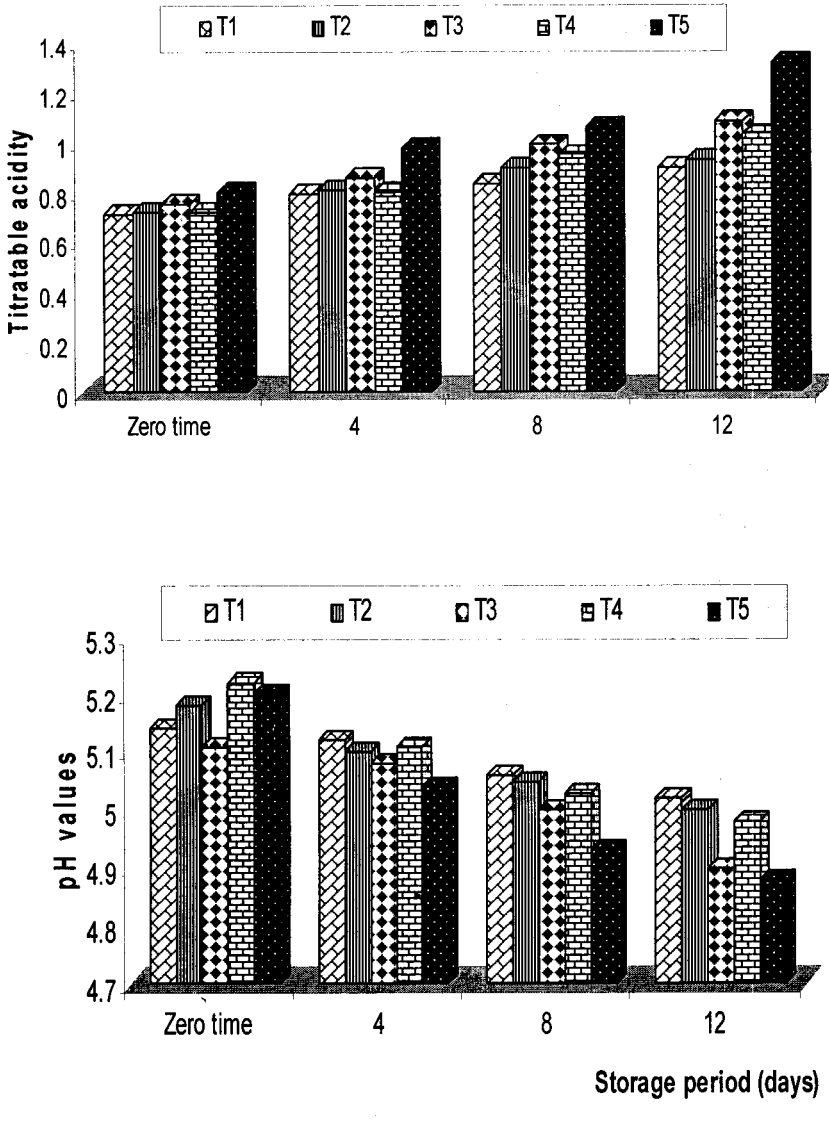

Fig. 1. Titratable acidity and pH values of yoghurt fortified with mushroom.

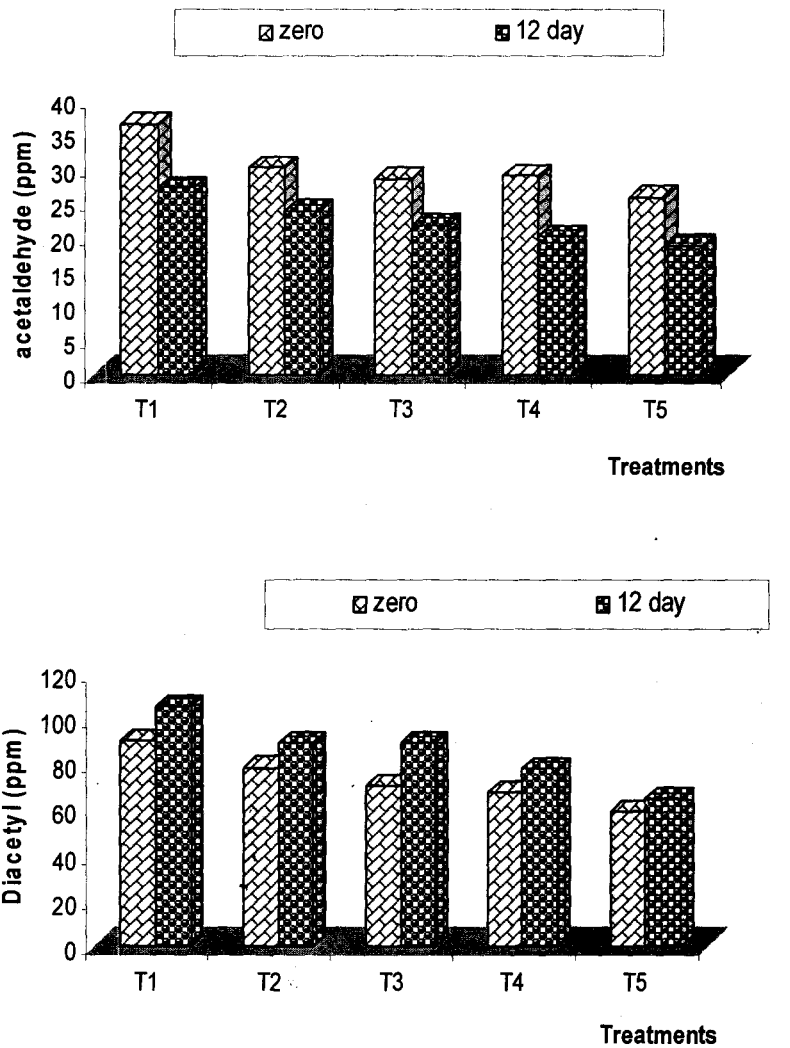

Fig. 2. The acetaldehyde and diacetyl values ppm of yoghurt fortificated with mushroom.

Table 1. Chemical composition% of yoghurt fortified with mushroom.

Properties	Storage period (days)	Treatments				
		T_1	T_2	T_3	T_4	T_5
T.S	Zero	14.04^{Ed}	14.68^{Dd}	15.13^{Bd}	14.78^{Cd}	15.26^{Ad}
	4	14.30^{Ec}	14.87^{Dc}	15.22^{Bc}	15.14^{Cc}	15.35^{Ac}
	8	14.51^{Eb}	15.06^{Db}	15.57^{Ab}	15.29^{Cb}	15.44^{Bb}
	12	14.74^{Ca}	15.33^{Ba}	15.82^{Aa}	15.47^{Ba}	15.55^{Ba}
Fat	Zero	3.40^{Dc}	3.50^{Cc}	3.70^{Ac}	3.60^{Bc}	3.70^{Ac}
	4	3.50^{Db}	3.60^{Cb}	3.80^{Ab}	3.70^{Bb}	3.70^{Bc}
	8	3.50^{Db}	3.70^{Da}	3.80^{Ab}	3.80^{Ba}	3.80^{Ab}
	12	3.60^{Da}	3.70^{Ca}	3.90^{Aa}	3.80^{Ba}	3.90^{Aa}
Protein	Zero	4.37^{Ed}	4.55^{Dd}	4.83^{Bd}	4.62^{Cd}	4.91^{Ad}
	4	4.46^{Ec}	4.62^{Dc}	4.91^{Bc}	4.81^{Cc}	4.99^{Ac}
	8	4.63^{Eb}	4.75^{Db}	5.02^{Bb}	4.89^{Cb}	5.09^{Ab}
	12	4.70^{Ea}	4.78^{Da}	5.06^{Ba}	4.93^{Ca}	5.20^{Aa}
Carbohydrate	Zero	5.46^{Da}	5.80^{Aa}	5.74^{Ba}	5.66^{Ca}	5.72^{Ba}
	4	5.41^{Db}	5.75^{Ab}	5.60^{Cb}	5.61^{Cb}	5.69^{Bb}
	8	5.39^{Dc}	5.65^{Ac}	5.55^{Bc}	5.54^{Bc}	5.46^{Cc}
	12	5.36^{Dd}	5.62^{Ad}	5.51^{Bd}	5.46^{Cd}	5.27^{Ed}
Ash	Zero	0.81^{Ed}	0.83^{Dd}	0.86^{Cd}	0.90^{Bd}	0.93^{Ad}
	4	0.88^{Dc}	0.90^{Cc}	0.92^{Bc}	0.93^{Bc}	0.98^{Ac}
	8	0.94^{Eb}	0.96^{Db}	1.00^{Cb}	1.05^{Bb}	1.09^{Ab}
	12	1.00^{Da}	1.03^{Ca}	1.15^{Ba}	1.18^{Aa}	1.18^{Aa}

Different capital letters in the same row means the treatments are significantly different from each other.

Different small letters in the same column means the treatments are significantly different from each other.

T1 : Control. T2 : 0.5% mushroom cap powder.

T3 : 1.0 % mushroom cap powder. T4 : 0.5% mushroom steak powder.

T5 : 1.0% mushroom steak powder.

Table 2. Penetration and whey off values of yoghurt fortification with mushroom.

Properties	Storage period	Treatments*				
		T_1	T_2	T_3	T_4	T_5
Penetration (mm)	Zero	22.8^{Dd}	23.5^{Bc}	25.2^{Ad}	22.9^{Dd}	23.1^{Cd}
	4	23.4^{Cc}	24.6^{Bb}	26.9^{Ac}	23.5^{Dc}	23.7^{Cc}
	8	24.5^{Cb}	26.7^{Ba}	27.7^{Ab}	24.0^{Eb}	24.3^{Db}
	12	25.5^{Ca}	26.9^{Ba}	28.1^{Aa}	25.0^{Ea}	25.3^{Da}
Whey off (ml/50g)	Zero	21^{Da}	26^{Aa}	25^{ABa}	24^{BCa}	23^{Ca}
	4	20^{Cab}	25^{Aab}	24^{ABab}	23^{Bab}	23^{Ba}
	8	19^{Db}	24^{Ab}	23^{ABb}	21^{Cb}	22^{BCab}
	12	18^{Dbc}	23^{Abc}	21^{Bc}	19^{Cc}	20^{BCb}

* see table (1)

Table 3. Organoleptic evaluation of yoghurt pontificated with mushroom.

Properties	Storage period (days)	Treatments*				
		T_1	T_2	T_3	T_4	T_5
Flavor (45)	Zero	$40^{AB,a}$	$42^{A,a}$	$38^{B,a}$	$41^{A,a}$	$35^{C,a}$
Body & Texture		$40^{AB,a}$	$41^{A,a}$	$39^{BC,a}$	$41^{A,a}$	$38^{C,a}$
Appearance (10)		$8^{A,a}$	$8^{A,a}$	$7^{AB,a}$	$7^{AB,a}$	$6^{B,a}$
Total (100)		$88^{AB,a}$	$91^{A,a}$	$84^{BC,a}$	$89^{AB,a}$	$79^{C,a}$
Flavor (45)	4	$39^{BC,ab}$	$41^{A,ab}$	$38^{B,a}$	$40^{AB,ab}$	$34^{C,ab}$
Body & Texture		$40^{AB,a}$	$41^{A,a}$	$39^{BC,a}$	$40^{AB,ab}$	$38^{C,a}$
Appearance (10)		$8^{A,a}$	$8^{A,a}$	$7^{AB,a}$	$7^{AB,a}$	$6^{B,a}$
Total (100)		$87^{AB,ab}$	$90^{A,ab}$	$84^{B,a}$	$87^{AB,ab}$	$78^{C,ab}$
Flavor (45)	8	$38^{BC,b}$	$40^{A,b}$	$37^{C,ab}$	$39^{AB,b}$	$34^{D,ab}$
Body & Texture		$39^{AB,ab}$	$40^{A,ab}$	$38^{AB,ab}$	$40^{A,ab}$	$37^{B,ab}$
Appearance (10)		$8^{A,a}$	$8^{A,a}$	$6^{BC,b}$	$7^{AB,a}$	$5^{C,b}$
Total (100)		$85^{AB,b}$	$88^{A,b}$	$81^{B,b}$	$86^{AB,b}$	$76^{C,b}$
Flavor (45)	12	$36^{BC,c}$	$38^{A,c}$	$35^{C,b}$	$37^{AB,c}$	$32^{D,b}$
Body & Texture		$38^{BC,b}$	$40^{A,ab}$	$37^{C,b}$	$39^{AB,b}$	$36^{CD,b}$
Appearance (10)		$7^{A,b}$	$7^{A,b}$	$6^{BC,b}$	$6^{AB,b}$	$5^{C,b}$
Total (100)		$81^{B,c}$	$85^{A,c}$	$78^{BC,b}$	$82^{AB,c}$	$73^{C,c}$

* see table (1)

REFERENCES

1. A.O.A.C. 1995. Official Methods of Analysis Association of Official Analytical Chemistry. Washington, DC.
2. Abd El-Rahman, H. A. and W. M. Salama, 2008. Preparation of yoghurt-like products with safflower as a substitution material. Egyptian J. Diary Sci., 36: 39-44.
3. Abd El-Salam, M.H., S. El-Shibiny, M.B. Mahfuz, H.F. El-Dein, H. El-Ariby and V. Antila. 1991. Preparation of whey protein concentrate from salted whey and its use in yoghurt. J. of Dairy research 58:503.
4. Ahmed, A.G. 1997. Chemical and microbiological studies on processed cheese. M.Sc. Thesis, Fac. of Agric., Ain Shams Univ.
5. Ayar, A., A.Elgum,s and F. Yazici. 2005. Production of a high nutritional value, aromatized yoghurt with the addition of non-fat wheat germ. Australian J. Dairy Tech., 60(1) : 14-18.
6. Azzam, M. A. A. E. K. 1992. Studies on some chemical and microbiological properties of soybean milk. M. Sc. Thesis, Fac. of Agric., Cairo University, Egypt.
7. Bradley, R.L, E. Arnol, D.M. Barbano, R.G. Semerad, D. E. Smith and B.K. Vines. 1992. Chemical and physical methods. In, Marshall, R.T. (Ed), Standard method for the examination of dairy products. (16^{th} Ed, pp. 433-529).
8. Buwjoom T.S. Tangtaweewipat, Thomywittaya and K. Yamauch. 2004. Chemical composition nutrient digestibility and metabolisable energy of shiitak mushroom stalk meal. J. Poultry Sci., 41: 322-328.
9. Dirar, H. A. 1993. The indigenous fermented foods of the Sudan. A study in African university press, United Kingdom.
10. Diyabalanage, T., V. Mulabagal, G. L. Dewitt and M. G. Nair. 2008. Health-beneficial qualities of the edible mushroom, Agrocybe aegerita. Food Chem., 108: 97-102.
11. Eidi, A., M. Eidi and M.Sokhtel. 2007. Effect of fenujreek (*Trygomiella foenium-graasum L.*) seeds on serum parameter in normal and streptozototin-induced dipeteic rats. Nutr. Res. 27: 728-733.
12. El-etriby, H.M., R.T. El-Dalrouty and A.H. Zaghloul. 1997. Physicochemical and bacteriological studies on mango yoghurt manufacture from ultrafiltrated milk retentate using glucodeltalactone (GDL). Egyptian J. Dairy Sci., 25: 349-365

13. Fayed, A. E, M. F. Azza and O. M. Ragia. 2009. Use of mushroom powder for substituting dried skim milk in the manufacture of processed cheese spread. Egypt J. Agric. Res., 87(2).

14. Mallavadhani, U. V., A. V. S. Sudhakar, K. V. S. Satyanarayana, A. Mahapatra, W. Li and R. B. vanBreemen. 2006. Chemical and analytical screening of some edible mushrooms. Food Chem., 95: 58-64.

15. Manzi, P. and L. Pizzoferrato. 2000. Beta-glucans in edible mushrooms. Food Chem., 68: 315-318.

16. Manzi, P., L. Gambelli, S. Marconi, V. Vivanti and L. Pizzoferrato. 1999. Nutrients in edible mushrooms: an interspecies comparative study. Food Chem., 65: 477-482.

17. Ooi, V. E. C. 2000. medicinal important fungi. In Van Griensven (Ed.), Science and Cultivation of Edible Fungi (pp. 41-51). Retteerdam: Balkema.

18. Ooi, V. E. C. and F. Liu. 1999. A review of pharmacological activities of mushroom polysaccharides. Int. J. Medicinal Mushrooms, 1: 195-206.

19. Tamime, A.Y. and R.K. Robinson. 1997. Yoghurt science and technology (second edition). Wood head publishing Ltd, Cambridge, England.

إنتاج زبادي مدعم بعيش الغراب

وفاء محمود سلامة ، راجية عمر يوسف ، احمد صابر السيسى

معهد بحوث تكنولوجيا الأغذية – مركز البحوث الزراعية – الجيزة

تم استخدام عيش الغراب في صناعة الزبادي بغرض رفع قيمته الغذائية حيث تم استعمال عيش الغراب على صورتين الأولى mushroom cap powder (MCP) أوراق المشروم البودرة بنسبة إضافة ٠,٥ %، ١ % و الصورة الأخرى(MSP) mushroom steak powder سيقان المشروم البودرة أيضا بنسبة ٠,٥% ، ١ % و تم تحليل المعاملات المصنعة و المخزنة في الثلاجة على درجة حرارة ٥ ±٢٥م لمدة ١٢ يوم من ناحية التركيب الكيماوي و الصفات الريولوجية و كذلك الخواص الحسية. و لقد أوضحت النتائج الآتي:

- ازدادت قيم كل من الجوامد الكلية و الدهون و البروتين و اللاكتوز و الرماد في المعاملات المضاف إليها عيش الغراب عن المعاملة الكنترول و تزداد القيم كلما زادت نسبة إضافة عيش الغراب و أيضا زادت القيم مع فترة التخزين.
- إضافة المشروم الأوراق زاد من نعومة خثرة الزبادى وتلي ذلك الزبادى المضاف اليه مشروم السيقان وجاءت المعاملة الكونترول فى النهاية حيث أنها كانت الأعلى صلابة
- أما انفصال الشرش فقد زاد في كل المعالات عن المعاملة الكونترول كما انه زاد بزيادة نسبة الإضافة سواء للمشروم الأوراق أو السيقان. كما أن إضافة المشروم سواء أوراق او سيقان أدت إلى انخفاض محتوى الاسيتالدهيد والداى استيل في المعاملات عن الكونترول.
- حصل الزبادي المصنع بإضافة عيش الغراب بنسبة ٠,٥% MCP على أعلى درجات التحكيم ثم تلاه بعد ذلك الزبادي المصنع بإضافة ٠,٥ % MSP والزبادي الكنترول.

وكذلك توصى الدراسة بإمكانية إضافة مشروم الأوراق البودرة وخاصة بالنسبة الأقل (٠,٥%) إلى لبن الزبادي لتحسين خواصة وكذلك رفع قيمتة الغذائية