J. Food and Dairy Sci., Mansoura Univ., Vol. 6 (9): 547 - 564 , 2015

A STUDY ON IMPROVING THE FUNCTIONAL PROPERTIES OF CREAM

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ABSTRACT

The objective of this study was to improve the functional properties of cream and prolonging its shelf life. The cream whether fresh or sour, which is fortified with *A. bisporus* at levels 0, 3%, 6% and 9% and their effect on the composition, bacteriological, biochemical, rheological and organoleptic properties beside the nutritional and daily values. Cream containing 20% fat was made using fresh cream (60% fat), fresh skim buffalo's milk (0.1% fat) and fresh butter from buffalo's milk (0.3% fat). The results indicated that the addition of *A. bisporus* at all levels was of remarkable effect on the total solid, fat, total protein, ash, fiber and total carbohydrates. The data clear that there is a relationship between the bacterial population and the supplementing of *A. bis from porus*'slevel. Lioplytic and proteolytic bacteria, yeast and mold were not detected in cream. The acidity content decreased while the pH increased by increasing the level of *A. bisporus*. Acidity increased gradually in all treatments during storage period. Fresh cream fortified with *A. bisporus* exhibited lower peroxide value than sour cream fortified with *A. bisporus*.The obtained results indicated that cream fortified with *A. bisporus* was significantly distinguished with increase values of total mono and total poly unsaturated fatty acids, viscosity, total flavonoids, β- carotene, niacin, phenolates and folates, while the values of cholesterol and vitamin E decreased. All cream treatments made with *A. bisporus* had acceptable flavor, body and texture and appearance during storage period, except the treatment containing level 9% of *A. bisporus*, whitch had the lowest total score. Consequently, it is possible to produce a functional cream with excellent sensory attributes and shelf life using *A. bisporus* at a level 6%.

Keywords: Mushroom, *Agaricusbisporus*, cream, sour cream, butter milk

INTRODUCTION

Cream contains more of the fat-soluble vitamins than original milk, but the content of the water-soluble vitamins is reduced only a litter. The higher valuesof protein, lactose and minerals relate to the low fat creams.

Buttermilk is the aqueous phase released during thechurning of cream in butter manufacture. It containsall the water-soluble components of cream such as milkprotein, lactose, and minerals. It also encloses materialderived from milk fat globule membrane (MFGM),which is disrupted during the churning and mostly migratesto the buttermilk fraction (Corredig and Dalgleish1997). Buttermilk contains more phospholipids,than milk because of its high content in MFGM material,which is rich in phospholipids that constitute aboutone-third of the MFGM DM (Mulder and Walstra,1974). For instance, Ellinge*t al.* (1996) reported 7 timesmore phospholipids in

buttermilk than in whole milk,with concentrations equal to 0.89 mg/g and 0.12 mg/g,respectively. Christie *et al.* (1987) determined a 4-foldincrease of phospholipids in buttermilk compared withwhole milk, with a phospholipid content of 0.72 mg/mL and 0.15 mg/mL, respectively. The high content ofphospholipids in buttermilk makes this dairy ingredientinteresting for use as a functional ingredient becauseof the emulsifying properties of phospholipids(Ellinge*t al.,* 1996; Corredig and Dalgleish, 1998a;Wong and Kitts, 2003). In addition, phospholipids havebeen shown to possess biological activity. Some studieshave demonstrated the anticarcinogenic potential ofphospholipids, especially against colon cancer (Dillehaye*t al.,* 1994; Schmelze*t al.,* 1996, 1998), as well as theirprotective effect against bacterial toxins and infection(Rueda *et al.,* 1998).

Dietary fibers (DF) are the edible parts of plants or analogous carbohydrates that are resistant to digestion and absorption in the human small intestine which undergo complete or partial fermentation in the large intestine (AACC,2001). The DF includes two major classes depending on their intestinal solubility i.e. soluble fibers (pectins, mucilage, loosely bound hemicelluloses, beta-glucans, and a large range of non-digestible oligosaccharides, including inulin) and insoluble fibers (cellulose, lignin, and tightly bound celluloses) (Rodrguez*et al.,* 2006; Alvarez and Pea-Valdivia, 2009). The recommended daily intake of fibers is about 38g for men and 25g for women.

There has been a recent upsurge of interest in mushrooms not only as a health vegetable (food) which is rich in protein but also as a source of biologically active compounds of medicinal value. Uses include complementary medicine/dietary supplements for anticancer, antiviral, immunopotentiating, hypocholesterolemic, and hepatoprotective agents. This new class of compounds, termed mushroom nutriceuticals(Chang andBuswell, 1996), are extractable from either the mushroom mycelium or fruiting body and represent an important component of the expanding mushroom biotechnology industry. It has been shown that constant intake of either mushrooms or mushroom nutriceuticals (dietary supplements) can make people fitter and healthier. In addition, mushroom cultivation can also help to convert agricultural and forest wastes into useful matter and reduce pollution in the environment. Therefore, mushroom cultivation can make three important contributions: production of health food, manufacture of nutriceuticals, and reduction of environmental pollution.

One way in which foods can be modified to become functional is by addition of Prebiotics.Its are non-digestible dietary components that pass through the colon and selectively stimulate the proliferation and/or activity of probiotic bacteria in the colon (Mattila-Sandholm*et al.,* 2002).Synbiotic is a product in which both a probiotic and prebiotic are combined in a single product. It is defined as a mixture of probiotics and prebiotics that beneficially affects the host by improving the survival and implantation of probiotic in gastrointestinal tract (Salminen*et al*.,1998 and Gibson,1999).After all, this research was done to study the possibility of producing functional cream by using *A. bisporus.*

MATERIALS AND METHODS

Fresh buffalo's milk was obtained from experimental station at Mahalet Moussa, Animal production Research Institute, Egypt. Fresh skim buffalo's milk (0.1% fat) and fresh cream (60%) were prepared from the previous whole buffalo's milk using a separator. Fresh butter buffalo's milk (0.3% fat) was prepared by churning sweet buffalo's cream using stainless steel churrn. Freeze dried starter culture (FD-DVS YC-X11) containing *Lactobacillus delbrueckii* ssp.*bulgaricus* and *Streptococcus thermophilus* were obtained from Chr. Hansen A/S, DK-2970 Horsholm, Denmark. Mushroom **(***Agaricusbisporus*) was obtained from local market at cairo, Egypt.

Table (1):The chemical composition of *Agaricusbisporus.*

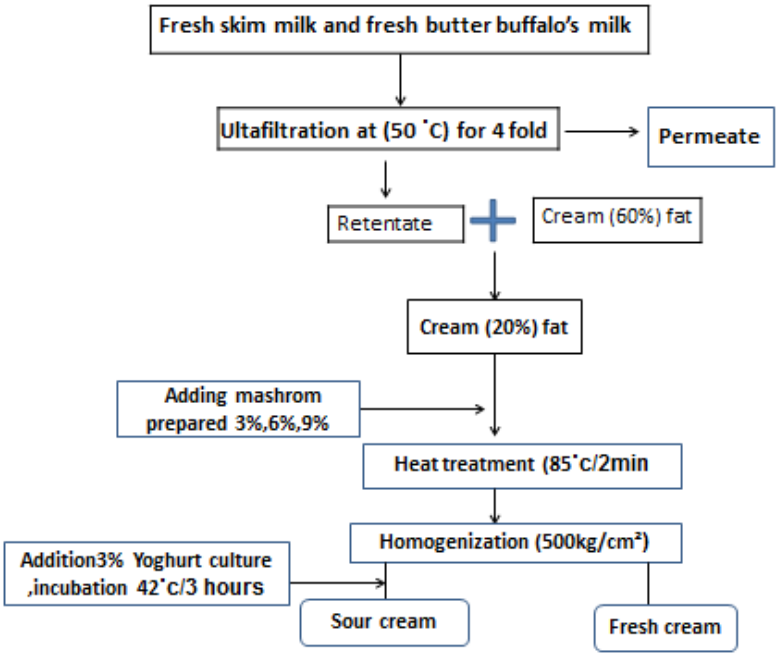
Chemical composition	
Dry matter %	13.27
Fat %	0.242
Protein %	4.976
Ash %	1.798
Fiber %	2.057
Available Carbohydrates %	4.197
K (mg/100g Dw)	3422
P(mg/100g Dw)	8342
Mg (mg/100g Dw)	164
Zn (mg/100g Dw)	8.30
Cu (mg/100g Dw)	2.84
Fe (mg/100g Dw)	10.38
Mn(mg/100g Dw)	1.93
Riboflavin(B_2)(mg/100g Dw)	4.60
Niacin (mg/100g Dw)	54
Thiamin (B_1) (mg/100g Dw)	0.80
B_{12}(µg/100g DW)	0.8
Biotin(µg/100g DW)	170

Total Protein = N x 4.38

All microbiological media used which were ready made: MRS agar (BiolifeItaliana, Italy) were obtained from El Badr Company, Egypt. Malt extact

Cooked mushroom was prepared by soaking the cleaned small pieces of mushroom in water (1 kg mushroom/ 200 ml water) and boiled for 10 min, then the mixture (mushroom and water) was mined and blended to get very fine paste and kept frozen until used.

The following diagram shows the processing steps of fresh cream and sour cream



The fresh cream was divided into 4 equal portions. The first portion served as control, to the second portionmushroom was added at level of 3%, to the third portion mushroom was added at level of 6%,and to the fourth portion mushroom was added at level of 9%.

Also,the sour cream was divided into 4 equal portions and the same previous will be done on the sour cream.

Dry matter, protein,fat, ash,titratable acidity and fiber contents were determined as reported by the AOAC, (2007). Fatty acids were determined as described by De Jong and Herman (1990).The pH value was measured electrometrically using Lab. pH meter with a glass electrode, Hanna digital pH meter. The viscosity of cream was determined by Brookifield DV- E viscometer using spindle 5 at rpm 20 in 200 ml of cream sample. The temperature was maintained at 25^{o} C and viscosity value was expressed in centipoises (cp).Peroxide value and Niacin were determined according to the method described by AOAC (2000).Totalflavonoids content of cream samples were determined as mentioned by Jia- Zhishen*et al* (1999).β-Carotene was determinedas described by Barros *et al* (2010). Vit. E was determined as described by Herrero *et al.* (2002).Total cholesterolwas determinedas described byPantulu*et al* (1975).Total phenolic compounds were determined according to (Zheng & Wang, 2001).Folates content were determined as mentioned by Holt *et al.(*1988).Carbohydrate content of all samples werecalculated as described by Ceirwyn, (1995)using the following formula:

% Available carbohydrates = 100 – (%fat+%protein+% ash+%fiber +% moisture).

Total bacterial count of cream was enumerated after incubation at 32^0 C/ 2 days using plate count agar according to Marshall (1992). Yeast and Molds, Lipolytic bacteria and proteolytic bacteria were determined according to APHA (1994).

Sensory evaluation of cream samples was doneduring storage period by the staff members of Dairy Chemistry Department, Animal Production Research Institute,according tokeating and White (1991).

Nutritional daily values of cream were calculated using food tables (FDA, 2013)

The data obtained were statistical analyzed according to statistical analyses system user's guide (SAS, 1996).

RESULTS AND DISCUSSION

As present in Table (2), supplementing with *A. bisporus* led to significant differences($P< 0.001$) in the dry matter (DM) contents of the resultant cream according to the additional level of *A. bisporus*. Content of protein, ash and fiber increased while the fat and available carbohydrates decreased significantly by increasing the level of *A. bisporus*.

The obtained results indicated that neither fat nor available carbohydrates were influenced by the type of cream at any level of *A. bisporus* supplementation.

With regard to the protein, ash and fiber contents of cream, data illustrated in table (2) confirmed that the protein, ash and fiber contents increased significantly ($P< 0.001$) as the supplementing level with *A. bisporus* increased.

Table (2): Chemical composition of fresh and sour cream fortified with different level of *Agaricusbisporus.*

Component (%)	Treatments							
	Fresh cream				Sour cream			
	Levels of supplementing with mushroom (%)							
	Control	3	6	9	Control	3	6	9
Dry matter	$28.501^{a,b}$	$28.044^{b,b}$	$27.587^{c,b}$	$27.130^{d,b}$	$28.502^{a,a}$	$28.043^{b,a}$	$27.588^{c,a}$	$27.129^{d,a}$
Fat	$20.100^{a,a}$	$19.504^{b,a}$	$18.909^{c,a}$	$18.313^{d,a}$	$20.100^{a,a}$	$19.503^{b,a}$	$18.909^{c,a}$	$18.312^{d,a}$
Protein	$3.420^{d,a}$	$3.466^{c,a}$	$3.514^{b,a}$	$3.560^{a,a}$	$3.422^{d,b}$	$3.467^{c,b}$	$3.513^{b,b}$	$3.560^{a,b}$
Ash	$0.721^{d,a}$	$0.7534^{c,a}$	$0.7856^{b,a}$	$0.8179^{a,a}$	$0.720^{d,b}$	$0.7533^{c,b}$	$0.7856^{b,b}$	$0.8180^{a,b}$
Fiber	-	$0.0620^{c,a}$	$0.123^{b,a}$	$0.185^{a,a}$	-	$0.0610^{c,b}$	$0.124^{b,b}$	$0.185^{a,b}$
Available Carbohydrates	$4.260^{a,a}$	$4.2586^{b,a}$	$4.2554^{c,a}$	$4.2541^{d,a}$	$4.261^{a,a}$	$4.2587^{b,a}$	$4.2564^{c,a}$	$4.2540^{d,a}$

The letters before comma possess the factor of mushroom level. While those after comma possess the kind of cream. The means with the same letter at any position did not significantly differ (P>0.05)

Data given in Table (3) Indicated that TC decreased significantly (P< 0.001) with the prolonging of storage period in all treatments of cream fortified with *A. bisporus*, while increased in the control. There are reverse relationships between TC and additional level of *A. bisporus*.*The lipolytic, proteolytic and moulds and yeasts counts were affected with addition of *A. bisporus*. These counts were not detected in all treatments when fresh and through storage period. Nevertheless, it appeared in samples of control after 3 weeks. This might be due to antimicrobial activity of *A. bisporus*. These findings coincidence with those reviewed by Stojkovic*et al.*(2014), who described the effects of methanolic extracts of *Agaricus* sp. against six species of Gram-positive bacteria, seven species of Gram-negative bacteria and three species of yeast.

Table (3): Microbiological quality(log CFU/ mL) of fresh and sour cream fortified with different level of *Agaricusbisporus.*

Cold storage period (weeks)	Treatments							
	Fresh cream				Sour cream			
	Levels of supplementing with *Agaricusbisporus* (%)							
	control	3	6	9	control	3	6	9
	Total count bacteria							
0	$4.379^{a,a,a}$	$4.337^{b,a.a}$	$4.301^{c,a.a}$	$4.289^{c,a.a}$	$4.382^{a,b.a}$	$4.341^{b,b,a}$	$4.321^{c,b,a}$	$4.297^{c,b,a}$
1	$4.405^{a,a,b}$	$4.282^{b,a.b}$	$4.233^{c,a.b}$	$4.184^{c,a.b}$	$4.400^{a,b.b}$	$4.237^{b,b,b}$	$4.145^{c,b,b}$	$4.058^{c,b,b}$
2	$4.499^{a,a,c}$	$4.163^{b,a.c}$	$3.872^{c,a.c}$	$3.814^{c,a.c}$	$4.513^{a,b.c}$	$4.016^{b,b,c}$	$3.714^{c,b,c}$	$3.681^{c,b,c}$
3	$4.563^{a,a,d}$	$3.786^{b,a.d}$	$3.594^{c,a.d}$	$3.507^{c,a.d}$	$4.556^{a,b.d}$	$3.587^{b,b,d}$	$3.470^{c,b,d}$	$3.375^{c,b,d}$
4	$4.827^{a,a,e}$	$3.594^{b,a.e}$	$3.450^{c,a.e}$	$3.322^{c,a.e}$	$4.686^{a,b.e}$	$3.292^{b,b,e}$	$3.187^{c,b,e}$	$3.124^{c,b,e}$
	Proteolytic bacteria							
0	ND	ND	ND	ND	ND	ND	ND	ND
1	ND	ND	ND	ND	ND	ND	ND	ND
2	ND	ND	ND	ND	ND	ND	ND	ND
3	$1.398^{a,a,b}$	ND	ND	ND	$1.342^{a,a,b}$	ND	ND	ND
4	$2.505^{a,a,a}$	ND	ND	ND	$2.486^{a,a,a}$	ND	ND	ND
	Lipolytic bacteria							
0	ND	ND	ND	ND	ND	ND	ND	ND
1	ND	ND	ND	ND	ND	ND	ND	ND
2	ND	ND	ND	ND	ND	ND	ND	ND
3	$1.337^{a,a,b}$	ND	ND	ND	$1.293^{a,a,b}$	ND	ND	ND
4	$2.656^{a,a,a}$	ND	ND	ND	$2.462^{a,a,a}$	ND	ND	ND
	Mold and yeast							
0	ND	ND	ND	ND	ND	ND	ND	ND
1	ND	ND	ND	ND	ND	ND	ND	ND
2	ND	ND	ND	ND	ND	ND	ND	ND
3	$1.284^{a,a,b}$	ND	ND	ND	$1.267^{a,a,b}$	ND	ND	ND
4	$2.117^{a,a,a}$	ND	ND	ND	$1.944^{a,a,a}$	ND	ND	ND

The letters before comma possess the factor of mushroom level. While those after comma possess the factor of the cream and storage period, respectively. The means with the same letter at any position were not significantly different (P>0.05)

It is obvious from data in Table (4) that by supplementing with *A. bisporus*, significant differences (P< 0.001) in T.A% and pH value of resultant cream were detected. The data showed that the control had the highest T.A% when fresh and during the storage period, whether fresh or sour cream However, the fresh cream treatment with *A. bisporus* at level 9% had the lowest value in T.A% and the highest pH value. Moreover, the level of acidity produced in sour cream was significantly higher than fresh cream (P< 0.001). Similar results were reported by Yadov and Srinivaisan(1985) who studied the effect of lactic cultures in ripening cream for use in ghee preparation. Generally, the prolonging of storage period of cream resulted in a significant increase (p<0.001) in T.A% and significant reduction (p<0.001) in pH value.

Table (4): Titratable acidity and pH of fresh and sour cream fortified with different level of *Agaricusbisporus*.

Cold storage period (weeks)	Treatments							
	Fresh cream				Sour cream			
	Levels of supplementing with *Agaricusbisporus* (%)							
	Control	3	6	9	control	3	6	9
	Titratable acidity							
0	$0.76^{a,b,e}$	$0.75^{b,b,e}$	$0.75^{c,b,e}$	$0.73^{d,b,e}$	$0.80^{a,a,e}$	$0.78^{b,a,e}$	$0.77^{c,a,e}$	$0.76^{d,a,e}$
1	$0.79^{a,b,d}$	$0.77^{b,b,d}$	$0.76^{c,b,d}$	$0.74^{d,b,d}$	$0.82^{a,a,d}$	$0.80^{b,a,d}$	$0.79^{c,a,d}$	$0.77^{d,a,d}$
2	$0.81^{a,b,c}$	$0.79^{b,b,c}$	$0.78^{c,b,c}$	$0.76^{d,b,c}$	$0.86^{a,a,c}$	$0.84^{b,a,c}$	$0.83^{c,a,c}$	$0.80^{d,a,c}$
3	$0.85^{a,b,b}$	$0.81^{b,b,b}$	$0.80^{c,b,b}$	$0.78^{d,b,b}$	$0.90^{a,a,b}$	$0.87^{b,a,b}$	$0.86^{c,a,b}$	$0.82^{d,a,b}$
4	$0.90^{a,b,a}$	$0.86^{b,b,a}$	$0.83^{c,b,a}$	$0.81^{d,b,a}$	$0.93^{a,a,a}$	$0.91^{b,a,a}$	$0.89^{c,a,a}$	$0.84^{d,a,a}$
	pH							
0	$4.60^{b,a,a}$	$4.63^{ab,a,a}$	$4.65^{a,a,a}$	$4.68^{a,a,a}$	$4.55^{b,b,a}$	$4.58^{ab,b,a}$	$4.61^{a,b,a}$	$4.63^{a,b,a}$
1	$4.56^{b,a,ab}$	$4.60^{ab,a,ab}$	$4.63^{a,a,ab}$	$4.65^{a,a,ab}$	$4.52^{b,b,ab}$	$4.55^{ab,b,ab}$	$4.58^{a,b,ab}$	$4.59^{a,b,ab}$
2	$4.53^{b,a,ab}$	$4.58^{ab,a,ab}$	$4.60^{a,a,ab}$	$4.63^{a,a,ab}$	$4.48^{b,b,ab}$	$4.52^{ab,b,ab}$	$4.54^{a,b,ab}$	$4.56^{a,b,ab}$
3	$4.50^{b,a,b}$	$4.55^{ab,a,b}$	$4.58^{a,a,b}$	$4.60^{a,a,b}$	$4.43^{b,b,b}$	$4.50^{ab,b,b}$	$4.50^{a,b,b}$	$4.53^{a,b,b}$
4	$4.41^{b,a,c}$	$4.48^{ab,a,c}$	$4.50^{a,a,c}$	$4.54^{a,a,c}$	$4.38^{b,b,c}$	$4.44^{ab,b,c}$	$4.47^{a,b,c}$	$4.49^{a,b,c}$

The letters before comma possess the factor of mushroom level. While those after comma possess the factor of the cream and storage period, respectively. The means with the same letter at any position were not significantly different (P>0.05)

The results in Table (5) indicated that peroxidase value (PV) in fresh cream and sour cream samples was affected by addition of *A. bisporus*. In addition, PV developed at a considerably higher rate in control sour cream than that of control fresh creamthrought the storage period.Peroxide values of all cream treatments increased through the storage period. At the end of storage period, controltreatments whether fresh cream or sour cream exhibited the highest PV, 0.90 or 0.99 (meq oxygen/kg fat) respectively. Fresh cream treatments incorporated with 3,6,9% of *A. bisporus*recorded, 0.65, 0.48, 0.40 of PV respectively at the end of storage period, while sour cream treatments fortified by, 3, 6, 9% of *A. bisporus*attained o.75, 0.59, 0.50

of PV respectively at the end of storage. Furthermore, fresh cream treatments fortified with different levels of *A. bisporus*exhibited lower PV than fortified sour creamtreatments. These results are close with(Kasuga*et al*., 1993) who reportedmushrooms possess many antioxidant properties. The stabilization of fresh cream and sour cream containing *A. bisporus*may be due to the presence of higher concentration of phenolic, antioxidants which inhibited fat oxidation.*A. bisporus* showed high antioxidant activity in assay, such as Flavonoids,β- Carotene,Vit. E,Niacin,Phenolatesand Folates. Moreover, both cream and sweet butter milk contain antioxidant compounds.

Table (5): Peroxide values(meq oxygen/kg fat) of fresh and sour cream fortified withdifferent level of *Agaricusbisporus.*

Cold storage period (weeks)	Treatments							
	Fresh cream				Sour cream			
	Levels of supplementing with *Agaricusbisporus* (%)							
	control	3	6	9	control	3	6	9
	Peroxide value							
0	$0.00^{a,b,e}$	$0.00^{b,b,e}$	$0.00^{c,b,e}$	$0.00^{d,b,e}$	$0.00^{a,a,e}$	$0.00^{b,a,e}$	$0.00^{c,a,e}$	$0.00^{d,a,e}$
1	$0.25^{a,b,d}$	$0.21^{b,b,d}$	$0.19^{c,b,d}$	$0.16^{d,b,d}$	$0.27^{a,a,d}$	$0.23^{b,a,d}$	$0.20^{c,a,d}$	$0.18^{d,a,d}$
2	$0.40^{a,b,c}$	$0.33^{b,b,c}$	$0.29^{c,b,c}$	$0.25^{d,b,c}$	$0.52^{a,a,c}$	$0.40^{b,a,c}$	$0.32^{c,a,c}$	$0.28^{d,a,c}$
3	$0.62^{a,b,b}$	$0.57^{b,b,b}$	$0.39^{c,b,b}$	$0.31^{d,b,b}$	$0.71^{a,a,b}$	$0.63^{b.a.b}$	$043^{c,a,b}$	$0.39^{d,a,b}$
4	$0.90^{a,b,a}$	$0.65^{b,b,a}$	$0.48^{c,b,a}$	$0.40^{d,b,a}$	$0.99^{a,a,a}$	$0.75^{b,a,a}$	$0.59^{c,a,a}$	$0.50^{d,a,a}$

The letters before comma possess the factor of mushroom level. While those aftercomma possess the kind of cream and storage period, respectively. The means with the same letter at any position were not significantly different (P>0.05)

It could be noticed from the data in Table (6) that there are significant increases in the saturated fatty acids, mono unsaturated fatty acids and poly unsaturated fatty acids content of cream associated with the proportion of the supplementing level with *A. bisporus* .Data showed that, the kind of cream had no significant differences (P< 0.05) in the saturated fatty acids, mono unsaturated fatty acids and poly unsaturated fatty acids content. It could also be seen from

Table (6), that the cream fortified with *A. bisporus* was a good source for margaric, stearic, arachidic, gadoleic, palmitic, oleic and linoleic. The levels of polyunsaturated fatty acids in mushrooms are high, constituting more than 75%of the total fatty acids, of which palmitic,oleicand linoleicacids are the most significant (Díez and Alvarez, 2001; J. H. Yang *et al.,* 2002).

Regarding viscosity for all cream treatments whether fresh cream or sour cream,it was noticed thatadding *A. bisporus* with different levels had an effect on the viscosity(Fig. 2).

The values were 754,768 cp for control; 789,793 cp at 3% of *A. bisporus;* 823,835cp at 6% of *A. bisporus*and 865,878 cp at 9%of*A. bisporus* for fresh and sour cream respectively befor storage period.

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The data indicated that the treatments of Sour or fresh creamwith 9%of *A. bisporus* had higher viscosity value than that in treatments fortified with 3% and 6% *A. bisporus*or control. The viscosity value were754 and 768 cp for fresh and sour cream of control treatments before storage while were 789, 793 in treatments with 3% of *A. bisporus*and 823, 835with 6% of *A. bisporus*for fresh and sour cream. The corresponding values in treatments with 9% *A. bisporus* were 865 and 878cp in same order. The obtained data also indicated that the viscosity was highier in treatments with sour cream than fresh cream. That could be due to that dietry fiber had desirable functional properties, such as providing texture, gelling, thickening, emulsification, and stabilization in DF-enriched foods (Nelson, 2001).

Therefore, DF research, particularly in the growing nutraceutical industry, has gained a lot of attention recently (Jalili*et al.,* 2000). The results also showed that theincreasing of the ratio added of *A. bisporus* caused significant increase in viscosity.

Furthermore, the rheological parameters of all cream treatments raised as a function of cold storage period for 4 weeks. That might be due to the acidity developed as the cold storage period prolonged. Those observations agreed with those reported by Huseine*t al*. (2006).

Data in Fig. (2) showed that the treatment sour cream containing 9% *A. bisporus* had the highest viscosity.

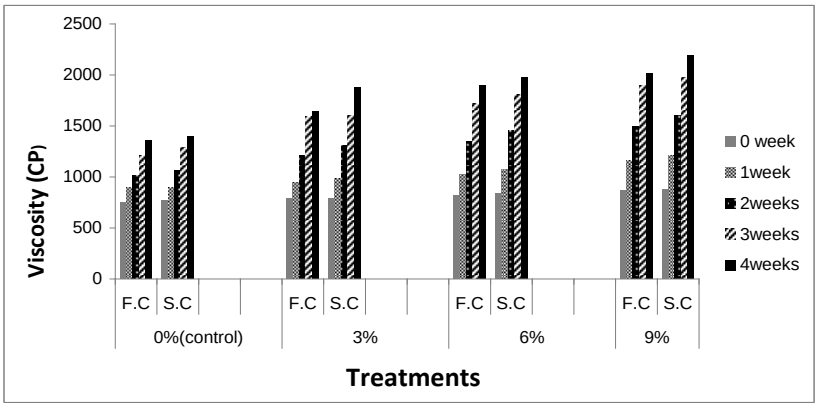

Fig. (2): Viscosity (cp) of creamas affected either by the level of supplementing *A. bisporus* or the type of cream.

Antioxidant content:

Data given in Table (7) stated that the kind of cream led to no significant differences (P>0.05) in the antioxidant contents of cream.

Data presented in Table (7) showed that adding *A. bisporus* caused significant (P<0.005)decrease in Vitamin E of cream comparing with the control, while flavonoids, β- Carotene, niacin, Phenolates and folates were significantly higher in the treatments fortified with *A. bisporus* than the control.

Also the addition of *A. bisporus* led to increase antioxidant content (flavonoids, β- Carotene, niacin, Phenolates and folates). While the kind of cream had no significant differences.

Furthermore, the kind cream whether fresh cream or sour cream fortified with levels of *A. bisporus* were rich in niacin, folate and β- Carotene comparing with the control(0.0 %).This further confirms that edible mushrooms have a potential as natural antioxidants due to the ability of their phenolics to inhibit lipid oxidation(Cheung *et al.,* 2003, 2005)

Table (7): Antioxidant of fresh and sour cream fortified with different level of *Agaricusbisporus*

Antioxidant	Treatments							
	Fresh cream				Sour cream			
	Levels of supplementing with mushroom (%)							
	Control	3	6	9	control	3	6	9
Flavonoids	-	$0.0519^{c,a}$	$0.1038^{b,a}$	$0.1557^{a,a}$	-	$0.0519^{c,b}$	$0.1039^{b,b}$	$0.1557^{a,b}$
β- Carotene(µg/g)	-	$0.1313^{c,a}$	$0.1875^{b,a}$	$0.2438^{a,a}$	-	$0.1312^{c,b}$	$0.1875^{b,b}$	$0.2439^{a,b}$
Vit. E(mg/100g)	$0.8300^{a,b}$	$0.8144^{b,b}$	$0.7988^{c,b}$	$0.7832^{d,b}$	$0.8310^{a,a}$	$0.8145^{b,a}$	$0.7989^{c,a}$	$0.7832^{d,a}$
Niacin(B_3)(mg/100g)	$0.5770^{d,b}$	$0.8031^{c,b}$	$1.0292^{b,b}$	$1.2035^{a,b}$	$0.6730^{d,a}$	$0.9132^{c,a}$	$1.1296^{b,a}$	$1.4014^{a,a}$
Phenolates(µg/g)	-	$0.0024^{c,a}$	$0.0050^{b,a}$	$0.0072^{a,a}$	-	$0.0024^{c,b}$	$0.0050^{b,b}$	$0.0071^{a,b}$
Folates(µg/g)	$33.200^{d,b}$	$35.9102^{c,b}$	$38.6204^{b,b}$	$41.3306^{a,b}$	$34.200^{d,a}$	$36.9302^{c,a}$	$39.6404^{b,a}$	$42.7306^{a,a}$

The letters before comma possess the factor of mushroom level. While those after comma possess the kind of cream. The means with the same letter at any position did not significantly differ (P>0.05) .

As with the cholesterol content, it was clear from Table (8) that significant variations were detected between the three levels of supplementing *A. bisporus* and the starter culture during the storage period. The treatments whether fresh cream or sour cream were able to assimilate cholesterol during storage, but the reduction of cholesterol in the treatments inculated with 9% sour cream was the highest comparing with 3%,6% and control of sour cream or fresh cream throughout the storage period. the level of supplementing *A. bisporus* had the highest percent of cholesterol reduction compared to standardized buffalo's cream (20% fat). This could be due to that *A. bisporus*is an ideal food for the dietetic prevention of atherosclerosis due to their high fiber and low fat content. The edible mushrooms in a natural hypocholesterolemic and antisclerotic diet is often prescribed in Oriental medicine (Sun *et al.,* 1984). Dietary fiber (nonstarch polysaccharides, mainly β-glucans) has also been suggested to be an important hypocholesterolemic component in mushrooms, fibers *A. bisporus* (button mushroom) can dramatically enhance the hepatic LDL receptor messenger RNA (mRNA), causing the diminution of the serum TC (Fukushima *et al.,* 2000, 2001). β-glucans extracts of cholesterol a fat by formation of an inclusion complex with β-glucans.

Table (9): Sensory evolution of fresh and sour cream fortified with different level 0f *Agaricusbisporus*

Cold storage period (weeks)	Treatments							
	Fresh cream				Sour cream			
	Levels of supplementing with *Agaricusbisporus* (%)							
	control	3	6	9	control	3	6	9
	Flavor (45)							
0	$45^{a,a,a}$	$45^{a,a,a}$	$45^{a,a,a}$	$44^{b,a,a}$	$45^{a,a,a}$	$45^{a,a,a}$	$45^{a,a,a}$	$44^{b,a,a}$
1	$45^{a,a,a}$	$45^{a,a,a}$	$45^{a,a,a}$	$44^{b,a,a}$	$45^{a,a,a}$	$45^{a,a,a}$	$45^{a,a,a}$	$44^{b,a,a}$
2	$45^{a,a,a}$	$45^{a,a,a}$	$45^{a,a,a}$	$43^{b,a,a}$	$45^{a,a,a}$	$45^{a,a,a}$	$44^{a,a,a}$	$43^{b,a,a}$
3	$44^{a,a,b}$	$44^{a,a,b}$	$44^{a,a,b}$	$42^{b,a,b}$	$44^{a,a,b}$	$44^{a,a,b}$	$43^{a,a,b}$	$41^{b,a,b}$
4	$42^{a,a,c}$	$43^{a,a,c}$	$43^{a,a,c}$	$40^{b,a,c}$	$42^{a,a,c}$	$43^{a,a,c}$	$41^{a,a,c}$	$40^{b,a,c}$
	Body and Texture (30)							
0	$30^{b,a.a}$	$30^{a,a,a}$	$30^{b,a,a}$	$30^{c,a,a}$	$30^{b,b,a}$	$30^{a,b,a}$	$30^{b,b,a}$	$30^{c,b,a}$
1	$30^{b,a.a}$	$30^{a,a,a}$	$30^{b,a,a}$	$29^{c,a,a}$	$30^{b,b,a}$	$30^{a,b,a}$	$29^{b,b,a}$	$28^{c,b,a}$
2	$30^{b,a.a}$	$30^{a,a,a}$	$30^{b,a,a}$	$27^{c,a,a}$	$30^{b,b,a}$	$30^{a,b,a}$	$28^{b,b,a}$	$26^{c,b,a}$
3	$28^{b,a.b}$	$30^{a,a,b}$	$30^{b,a,b}$	$26^{c,a,b}$	$28^{b,b,b}$	$29^{a,b,b}$	$27^{b,b,b}$	$25^{c,b,b}$
4	$27^{b,a.c}$	$29^{a,a,c}$	$29^{b,a,c}$	$24^{c,a,c}$	$26^{b,b,c}$	$28^{a,b,c}$	$26^{b,b,c}$	$23^{c,b,c}$
	Acidity(10)							
0	$10^{ab,a,a}$	$10^{a,a,a}$	$10^{ab,a,a}$	$10^{ab,a,a}$	$10^{ab,b,a}$	$10^{a,b,a}$	$10^{ab,b,a}$	$10^{ab,b,a}$
1	$10^{ab,a,a}$	$10^{a,a,a}$	$10^{ab,a,a}$	$9^{ab,a,a}$	$10^{ab,b,a}$	$10^{a,b,a}$	$9^{ab,b,a}$	$9^{ab,b,a}$
2	$9^{ab,a,b}$	$10^{a,a,b}$	$10^{ab,a,b}$	$9^{ab,a,b}$	$9^{ab,b,b}$	$9^{a,b,b}$	$8^{ab,b,b}$	$8^{ab,b,b}$
3	$8^{ab,a,b}$	$9^{a,a,b}$	$10^{ab,a,b}$	$9^{ab,a,b}$	$8^{ab,b,b}$	$9^{a,b,b}$	$8^{ab,b,b}$	$7^{ab,b,b}$
4	$7^{ab,a,c}$	$8^{a,a,c}$	$9^{ab,a,c}$	$8^{ab,a,c}$	$7^{ab,b,c}$	$8^{a,b,c}$	$7^{ab,b,c}$	$7^{ab,b,c}$
	Appearance (15)							
0	$15^{a,a,a}$	$15^{a,a,a}$	$15^{a,a,a}$	$15^{b,a,a}$	$15^{a,a,a}$	$15^{a,a,a}$	$15^{a,a,a}$	$15^{b,a,a}$
1	$15^{a,a,ab}$	$15^{a,a,ab}$	$15^{a,a,ab}$	$14^{b,a,ab}$	$15^{a,a,ab}$	$15^{a,a,ab}$	$14^{a,a,ab}$	$14^{b,a,ab}$
2	$15^{a,a,b}$	$15^{a,a,b}$	$15^{a,a,b}$	$13^{b,a,b}$	$15^{a,a,b}$	$15^{a,a,b}$	$14^{a,a,b}$	$13^{b,a,b}$
3	$13^{a,a,c}$	$14^{a,a,c}$	$14^{a,a,c}$	$13^{b,a,c}$	$13^{a,a,c}$	$14^{a,a,c}$	$12^{a,a,c}$	$11^{b,a,c}$
4	$12^{a,a,d}$	$13^{a,a,d}$	$13^{a,a,d}$	$11^{b,a,d}$	$12^{a,a,d}$	$13^{a,a,d}$	$12^{a,a,d}$	$10^{b,a,d}$
	Total score (100)							
0	$100^{b,a,a}$	$100^{a,a,a}$	$100^{b,a,a}$	$99^{c,a,a}$	$100^{b,b,a}$	$100^{a,b,a}$	$100^{b,b,a}$	$99^{c,b,a}$
1	$100^{b,a,b}$	$100^{a,a,b}$	$100^{b,a,b}$	$96^{c,a,b}$	$100^{b,b,b}$	$100^{a,b,b}$	$96^{b,b,b}$	$95^{c,b,b}$
2	$99^{b,a,c}$	$100^{a,a,c}$	$100^{b,a,c}$	$92^{c,a,c}$	$99^{b,b,c}$	$99^{a,b,c}$	$94^{b,b,c}$	$90^{c,b,c}$
3	$93^{b,a,d}$	$97^{a,a,d}$	$98^{b,a,d}$	$90^{c,a,d}$	$93^{b,b,d}$	$96^{a,b,d}$	$90^{b,b,d}$	$84^{c,b,d}$
4	$88^{b,a,e}$	$93^{a,a,e}$	$94^{b,a,e}$	$83^{c,a,e}$	$87^{b,b,e}$	$92^{a,b,e}$	$86^{b,b,e}$	$80^{c,b,e}$

The letters before comma possess the factor of mushroom level. While those after comma possess the kind of cream and storage period, respectively. The means with the same letter at any position were not significantly different (P>0.05)

Regarding the Sensory evaluation, the appearance and flavor score, data given in Table (9) exhibited no differences among all cream treatments whether fortified with *A. bisporus* or not (the control),until one week from storage. But with prolonging the cold storage period the sensory evaluation score tended to significant decrease (P< 0.001). Increasing *A. bisporus* level until 9%, resulted to slightly danker color and the body became thickness

which can explain the lower score of this treatment whether fresh or sour than control. The differences between the total score of cream fortified with 6% and control was not significant as indicated from Duncan's test. The sensory total score of cream which reflects the overall organoleptic quality of product reveal that, the supplementation of cream with 6% in fresh cream and 3% in sour cream led to improve the total sensory quality versus the control.

Nutritional and daily values

As with the nutritional and daily values, It could be noticed from the data in Table (10), there was significant decreases in the energy , fat and cholesterol content of cream associated with the proportional increase of the supplementing level with *A. bisporus*. Regarding the daily values% of the protein,data showed thatadding *A. bisporus* caused significant increase* in the daily values% of protein comparing with the control. As appeared from Table (10), neither the kind of cream nor the level of supplementing with *A. bisporus* led to any significant differences (P> 0.05) in the daily values% of the total carbohydrates. Daily values (%) of cholesterol decreased significantly as the supplementing level with *A. bisporus*increased, especially in sour cream. Data presented in Table (10) also showed that adding *A. bisporus* caused significant decrease in the daily values% of vit. E comparing with the control, but Niacin and folate was significantly higher than the control.

Table (10) Daily values (DV%) of nutrients in fresh and sour cream fortified with different level of *Agaricusbisporus*

	Units count	Treatments							
		Fresh cream				Sour cream			
		Levels of supplementing with mushroom (%)							
		Control	3	6	9	control	3	6	9
Nutrients:									
Energy	Kcal	$211.62^{a,a}$	$206.434^{b,a}$	$201.258^{c,a}$	$196.07^{d,a}$	$211.62^{a,a}$	$206.429^{b,a}$	$201.258^{c,a}$	$196.64^{d,a}$
Total Fat	G	$30.92^{a,a}$	$30.00^{b,a}$	$29.09^{c,a}$	$28.17^{d,a}$	$30.92^{a,a}$	$30.00^{b,a}$	$29.10^{c,a}$	$28.17^{d,a}$
Protein	G	$6.84^{d,a}$	$6.932^{c,a}$	$7.028^{b,a}$	$7.120^{a,a}$	$6.844^{d,b}$	$6.934^{c,b}$	$7.026^{b,b}$	$7.120^{a,b}$
Total carbohydrate	G	$1.420^{a,a}$	$1.419^{a,a}$	$1.418^{a,a}$	$1.418^{a,a}$	$1.420^{a,a}$	$1.419^{a,a}$	$1.418^{a,a}$	$1.418^{a,a}$
Cholesterol	Mg	$34.75^{a,a}$	$32.683^{b,a}$	$31.766^{c,a}$	$30.766^{d,a}$	$27.716^{a,b}$	$26.673^{b,b}$	$26.206^{c,b}$	$25.443^{d,b}$
Fiber	G	-	$0.248^{c,a}$	$0.492^{b,a}$	$0.740^{a,a}$	-	$0.244^{c,b}$	$0.496^{b,b}$	$0.740^{a,b}$
Vit E	IU	$4.150^{a,b}$	$4.072^{b,b}$	$3.994^{c,b}$	$3.916^{d,b}$	$4.150^{a,a}$	$4.072^{b,a}$	$3.994^{c,a}$	$3.916^{d,a}$
Niacin	Mg	$2.885^{d,b}$	$4.015^{c,b}$	$5.146^{b,b}$	$6.017^{a,b}$	$3.365^{d,a}$	$4.566^{c,a}$	$5.648^{b,a}$	$7.007^{a,a}$
Folate	µg	$8.30^{d,b}$	$8.977^{c,b}$	$9.655^{b,b}$	$10.332^{a,b}$	$8.30^{d,a}$	$9.232^{c,a}$	$9.910^{b,a}$	$10.682^{a,a}$

The letters before comma possess the factor of mushroom level. While those after comma possess the kind of cream. The means with the same letter at any position did not significantly differ (P>0.05).

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دراسة على تحسين الخواص الوظيفية للقشدة

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**** قسم تكنولوجيا الألبان، معهد بحوث تكنولوجيا الأغذية، مركز البحوث الزراعية، جيزة، مصر.**

يهدف هذا البحث إلى تحسين الخواص الوظيفية للقشدة مع إطالة مدة حفظها وذلك عن طريق تدعيم القشدة سواء الطازجة أو المتخمرة بالمشروم بنسب ٠، ٣%، ٦% ،٩% مع دراسة الخواص التركيبية, البكتريولوجية, الريولوجية والحسية خلال فترة التخزين بالاضافة الى تقدير القيمة الغذائية. ولتحقيق ذلك تم إنتاج قشدة أساسية تحتوى على ٢٠% دهن وذلك بإستخدام قشدة طازجة (٦٠% دهن)، لبن فرز(٠.١% دهن) ، لبن خض (٠.٣% دهن).

أوضحت النتائج أن هناك تاثير واضح على الجوامد الكلية، الدهن، البروتين، الرماد، الكربوهيدرات والألياف حيث أنه بزيادة نسبة إضافة المشروم انخفض كل من الجوامد الكلية، الدهن ،الكربوهيدرات بينما زادت نسبة البروتين والرماد.كما أن هناك علاقة عكسية بين العدد الكلى للبكتريا ونسبة إضافة المشروم فبزيادة النسبة المضافة يقل الحمل البكتيرى، ولم تتواجد أى أعداد من البكتريا المحللة للدهن او البروتين وكذلك لم تظهر الخمائر أو الفطريات إلا فى عينة الكنترول.

وقد قلت الحموضة بزيادة نسبة إضافةالمشروم بينما انخفض الـpH ومن الطبيعى أن تزيد الحموضة تدريجيا خلال فترة التخزين. بالنسبة لقيم البيروكسيد فقدأوضحت النتائج أن القشدة الطازجة أقل من القشدة المتخمرة.

أظهرت النتائج أيضا تميز القشدة بنوعيها والمضاف اليها المشروم زيادةفى كل من الأحماض الدهنية أحادية وعديدة عدم التشبع، اللزوجة، الفلافونات، البيتا كاروتين، النياسين، الفينولات والفولات بينما انخفضت قيم الكوليسترول وفيتامين E.

ومما سبق يمكن إستنتاج أنه يمكن بنجاح إنتاج قشدة وظيفية بخواص حسية ممتازة مع إطالة مدة حفظها وذلك بإضافة المشروم حتى نسبة ٦%.

Table (6): fatty acid of fresh and sour cream fortified with different level of *Agaricusbisporus*

Fatty acid(g/100g)	Treatments							
	Fresh cream				Sour cream			
Saturated fatty acids	levels of supplementing with mushroom (%)							
	Control	3	6	9	Control	3	6	9
Butyric($C_{4:0}$)	$0.6901^{a,b}$	$0.6693^{b,b}$	$0.6486^{c,b}$	$0.6279^{d,b}$	$0.6900^{a,a}$	$0.6693^{b,a}$	$0.6486^{c,a}$	$0.6279^{d,a}$
Caproic ($C_{6:0}$)	$0.4100^{a,b}$	$0.3890^{b,b}$	$0.3785^{c,b}$	$0.3749^{d,b}$	$0.4101^{a,a}$	$0.3891^{b,a}$	$0.3785^{c,a}$	$0.3748^{d,a}$
Caprylic($C_{8:0}$)	$0.2100^{a,b}$	$0.2052^{b,b}$	$0.2004^{c,b}$	$0.1956^{d,b}$	$0.2100^{a,a}$	$0.2051^{b,a}$	$0.2005^{c,a}$	$0.1956^{d,a}$
Capric($C_{10:0}$)	$0.4100^{a,b}$	$0.3986^{b,b}$	$0.3872^{c,b}$	$0.3758^{d,b}$	$0.4100^{a,a}$	$0.3987^{b,a}$	$0.3871^{c,a}$	$0.3758^{d,a}$
Lauric ($C_{12:0}$)	$0.4400^{a,b}$	$0.4298^{b,b}$	$0.4196^{c,b}$	$0.4094^{d,b}$	$0.4400^{a,a}$	$0.4297^{b,a}$	$0.4196^{c,a}$	$0.4095^{d,a}$
Myristic($C_{14:0}$)	$3.0700^{a,b}$	$2.9953^{b,b}$	$2.9206^{c,b}$	$2.8459^{d,b}$	$3.0701^{a,a}$	$2.9953^{b,a}$	$2.9206^{c,a}$	$2.8458^{d,a}$
($C_{15:0}$)	$0.2300^{d,aa}$	$0.2432^{c,aa}$	$0.2564^{b,aa}$	$0.2696^{a,aa}$	$0.2300^{d,ab}$	$0.2433^{c,ab}$	$0.2563^{b,ab}$	$0.2697^{a,ab}$
Palmitic($C_{16:0}$)	$3.8201^{d,b}$	$4.1266^{c,b}$	$4.4404^{b,b}$	$4.7398^{a,b}$	$3.8200^{d,a}$	$4.1266^{c,a}$	$4.4403^{b,a}$	$4.7398^{a,a}$
Margaric ($C_{17:0}$)	$0.1200^{d,a}$	$0.1524^{c,a}$	$0.1848^{b,a}$	$0.2172^{a,a}$	$0.1201^{d,b}$	$0.1523^{c,b}$	$0.1849^{b,b}$	$0.2172^{a,b}$
Stearic($C_{18:0}$)	$2.100^{d,a}$	$2.2335^{c,a}$	$2.3670^{b,a}$	$2.5005^{a,a}$	$2.100^{d,b}$	$2.2335^{c,b}$	$2.3670^{b,b}$	$2.5005^{a,b}$
Arachidic($C_{20:0}$)	$0.2001^{d,a}$	$0.2894^{c,a}$	$0.3788^{b,a}$	$0.4682^{a,a}$	$0.2000^{d,b}$	$0.2893^{c,b}$	$0.3789^{b,b}$	$0.4682^{a,b}$
Total S.F.A.	$11.7003^{d,a}$	$12.1182^{c,a}$	$12.5928^{b,a}$	$13.0284^{a,a}$	$11.7003^{d,b}$	$12.1179^{c,b}$	$12.5929^{b,b}$	$13.0284^{a,b}$
Mono unsaturated fatty acids								
Titradeceneic($C_{14:1}$)	$0.2801^{a,b}$	$0.2716^{b,b}$	$0.2632^{c,b}$	$0.2548^{d,b}$	$0.2800^{a,a}$	$0.2716^{b,a}$	$0.2632^{c,a}$	$0.2549^{d,a}$
Palmitoleic ($C_{16:1}$)	$0.5500^{a,b}$	$0.5461^{b,b}$	$0.5422^{c,b}$	$0.5383^{d,b}$	$0.5501^{a,a}$	$0.5460^{b,a}$	$0.5422^{c,a}$	$0.5382^{d,a}$
Oleic ($C_{18:1}$)	$4.6800^{d,a}$	$5.1576^{c,a}$	$5.6352^{b,a}$	$6.1128^{a,a}$	$4.6801^{d,b}$	$5.1575^{c,b}$	$5.6351^{b,b}$	$6.1128^{a,b}$
Gadoleic ($C_{20:1}$)	$0.0501^{d,a}$	$0.0683^{c,a}$	$0.0866^{b,a}$	$0.1049^{a,a}$	$0.0500^{d,b}$	$0.0684^{c,b}$	$0.0867^{b,b}$	$0.1049^{a,b}$
Total M.U.F.A	$5.5602^{d,a}$	$6.0436^{c,a}$	$6.5272^{b,a}$	$7.0108^{a,a}$	$5.5602^{d,b}$	$6.0435^{c,b}$	$6.5272^{b,b}$	$7.0108^{a,b}$
Poly unsaturated fatty acids								
Linoleic ($C_{18:2}$)	$0.4201^{d,a}$	$1.7244^{c,a}$	$3.0288^{b,a}$	$4.3332^{a,a}$	$0.4202^{d,b}$	$1.7245^{c,b}$	$3.0288^{b,b}$	$4.3331^{a,b}$
Linolenic ($C_{18:3}$)	$0.1802^{d,a}$	$0.2730^{c,a}$	$0.3672^{b,a}$	$0.4608^{a,a}$	$0.1800^{d,b}$	$0.2730^{c,b}$	$0.3673^{b,b}$	$0.4609^{a,b}$
Arachidonic($C_{20:4}$)	$0.3400^{a,b}$	$0.3331^{b,b}$	$0.3262^{c,b}$	$0.3193^{d,b}$	$0.3401^{a,b}$	$0.3330^{b,b}$	$0.3262^{c,b}$	$0.3192^{d,b}$
Total P.U.F.A	$0.9403^{d,a}$	$2.3305^{c,a}$	$3.7222^{b,a}$	$5.1133^{a,a}$	$0.9403^{d,b}$	$2.3305^{c,b}$	$3.7223^{b,b}$	$5.1132^{a,b}$
Total Fatty Acids	$18.2008^{d,a}$	$20.4847^{c,a}$	$22.8422^{b,a}$	$25.1525^{a,a}$	$18.2008^{d,b}$	$20.4843^{c,b}$	$22.8424^{b,b}$	$25.1524^{a,b}$

The letters before comma possess the factor of mushroom level. While those after comma possess the kind of cream. The means with the same letter at any position did not significantly differ (P>0.05) .