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USE OF MODERN TECHNOLOGIES TO BENEFIT FROM AGRICULTURE AND DAIRY WASTE TO PRODUCE DAIRY PRODUCTS FOR PEOPLE WITH SPECIAL NUTRITIONAL NEEDS

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ABSTRACT

The composition, proteolysis, sensory characteristics of low-fat Domaiti cheeses (70% fat reduction) made from buffaloes milk and containing our laboratory made fat replacers (fat replacer from whey or fat replacer from wheat bran) were examined throughout aging for 60 days. The low-fat variant without fat replacers (L) and the full-fat cheese (F) were also studied. All the control low-fat products showed reduced yield, whereas the moisture and protein content significantly increased; however, the cheeses containing fat replacers had higher moisture and yield values than the L product. The extent of proteolysis and lipolysis in the low-fat cheeses made with the fat replacers significantly increased compared to the F cheese. The sensory testing showed an improvement in body and appearance in the low-fat cheeses containing fat replacers, the product was rated as a harder cheese than its full-fat counterpart, but cheeses containing fat replacers wheat bran did not have clearly evident odor intensity. Overall, the full-fat and simplesse cheeses had more flavor and odor intensity scores than all low-fat variants. Total cholesterol (TC), triglycerides (TG), and low density lipoprotein cholesterol (LDL-c) in the serum significantly ($P \leq 0.05$) decreased by fat replacement Calculated atherogenic index significantly decreased ($P \leq 0.05$) by fat replacement.

KEYWORDS: Microparticulation machine\, local fat replacers, domiati cheese, feeding rats.

I -INTRODUCTION

Domiati cheese is the most popular soft cheese in Egypt. It can be consumed fresh or after pickling (Ayad 2009 monira 2017). Cardiovascular disease has risen steadily as a proportionate cause of mortality for both men and women, from 5 to 39.1% for men and from 2.9 to 27.2% of deaths for women (Galal, 2002). Chronic diseases associated with excessive fat intake including diabetes, heart diseases and obesity (Krauss, 2001 Wylie-Rosett, 2002 and Johns and Eyzaguirre, 2006).

Consumer demand for low fat foods has encouraged research on low fat cheese (Duxbury. 1989 and Simard, 1991). Problems of inferior organoleptic and physical properties in these products suggested the use of fat replacers to provide the desirable qualities of Domiati cheese. Many commercial fat replacers are now available to make superior low fat products (Hewitt 1993, Hoffmeister 1993, Mitchell 1993, Philipp Schenkel et al 2013, Lepilkina et al 2017 and Muge urgu 2019).

Fat replacers are used to provide some or all of the functional properties of fat while providing fewer calories than the fat being replaced. (Kun Liu et al 2015). They are either fat substitutes or mimetics. Fat substitutes are lipid- like substances intended to replace fats on a one to one basis. Fat mimetics are protein or carbohydrate ingredients which function by imitating the physical, textural mouth feel and organoleptic properties of real fats (Shaltout and Youssef, 2007, KunLiua et al 2014). Whey proteins and carbohydrate that have been microparticulated by heat and mechanical action are the only protein- and carbohydrate based fat replacers that have been proposed for use in cheese.

The objective of this work was to design and manufacture simple machine for this microparticulation process on a laboratory scale and test the resulting replacers to improve the quality of low fat Domiati cheese.

II-MATERIALS AND METHODS

1-Manufacture of microparticulation machine

In our project we design and carry out the manufacture of a simple microparticulation machine for students training. The machine manufacture fat replacer from either whey or agriculture waste on laboratory scales. This machine use extremely high shear during the denaturing process (fig. 1). The machine is a jacketed vat surrounded by either circulating hot or cold water. The machine is provided with a thermometer and a device which quickly rotate

at a speed of 3000 rotation / min causing extremely high shear during the mixture denaturing process.

2-Manufacture of fat replacer from whey (LS)

A mixture containing 100g dried whey, 100g skim milk powder, 5g pectin, two eggs, 1g citric acid and 1 liter water is prepared. This mixture must be in a condition to promote denaturation by heating immediately to 74 ºC and then heating at 80 ºC for 15 sec during extremely high shear in our microparticulation machine then quickly cooling to 20 ºC. The product is then dried at 70 ºC and minced to fine powder.

3-Manufacture of fat replacer from wheat bran (LZ)

A mixture of 300g wheat bran, calcium 20 parts per million, α amylase and 1 liter water with pH adjusted at 5.5.mixture is prepared and kept at room temperature for 3 hours. It is then heated to 90 ºC with extremely high shear during the denaturing in our microparticulation machine followed by Cooling to 20 ºC and adjusted pH to 3.5 to stop enzyme action. The product is then dried at 70 ºC and minced.

4-Manufacture of Domiati Cheese

The buffalo milk was used. Whole milk adjusted at 5%fat and low fat milk adjusted at 1.5 %fat were used to make controls cheeses (full-fat cheese (F) and the low-fat cheese without fat replacers (L)). Milk of 1.5 % fat was used for the manufacture of the low-fat cheeses made with fat replacers. Domiati cheese was made by the method of (Nadia 2008). Samples were taken for analysis from fresh cheese and cheese stored for 8 weeks at room temp.

5-Cheese analysis

Cheese samples were analyzed for moisture content, pH, fat total nitrogen, soluble nitrogen, non protein nitrogen according to ling 1963.The total volatile fatty acids were determined as given by Kosikowaski (1978). Sensory evaluation was performed by fifteen staff members. Cheese were evaluated for the flavor, body & texture and appearance.

6-Biological assay

Male albino rats of Sprague Dawely strain (n=4), weighing (100-110g) were kept under hygienic conditions for one week acclimatization period. Rats were fed on a basal casein diet according to Reeves et al., (1993). The water was supplied ad libitum. The rats were divided into five groups of five rats. The experiment lasted for a period of 4 weeks. Blood samples

were obtained. Triglycerides (TG), Total cholesterol and High Density lipoprotein cholesterol (HDL-cholesterol) were determined in serum as described by Fossati and Prencipe, (1982), Allian et al., (1974) and Lopez- Virella et al., (1977), respectively. Low density lipoprotein cholesterol (LDL-cholesterol) was calculated as described by Wardlaw and Snook (1990) as following:

LDL-cholesterol= Total cholesterol - HDL–cholesterol-(Triglyceride/5).

Atherogenic index was calculated using the following equation as described by Kawase etal., (2000). Atherogenic index= (Total cholesterol- HDL–cholestrol)/ HDL-cholestrol.

7-Statistical Analysis

All the obtained data were statistically analyzed by SPSS computer software according to (Abo- Allam, 2003).

Fig (1): Micoparticulation machine.

III. RESULTS AND DISCUSSION

1-Cheese Composition

Data in Table (1) clearly showed that pH of all cheese decreased significantly during storage period. The decrease in the first month in pH was higher than that occur in the second month of pickling Abdou et al (2003) and El Abd et al (2003). LS and LZ cheeses had significantly lower pH compared with L cheese. The pH of full-fat Domiati F cheese was lower than of the low-fat Domiati L cheeses during cheese ripening. Similar results have been obtained by Volikakis et al. 2004, Katsiari and Voutsinas 1994 and Tareq Alnemr 2017.

Table (1) also showed a significant decrease ($P < 0.05$) in moisture content ($P < 0.05$)of cheese during cheese ripening (Kaya 2002; Melilli et al. 2005; Khosrowshahi et al. 2006; Madadloua et al. 2007; Sadowska et al. 2009). There was a difference ($P < 0.05$) in the moisture content of the cheeses as a result of adding fat replacers (Table 1). Low fat cheeses made with the whey-based replacers (LS) or carbohydrate-based fat replacers (LZ) had higher moisture contents, respectively, than did the control cheese. This agrees with the observations of Lucey and Gorry (12). The low fat cheeses contained the lowest moisture. This may be due to the high water holding capacity of both fat and fat replacers, Ayat 2016 monira 2017 and Tareq Alnemr 2017.

There is a significant increase in total nitrogen content (TN) of low fat cheese(L ,LS and LZ cheeses) ($P < 0.05$) (Table 1). These results are in agreement with the literature (Madadloua et al. 2007;Korish and Abd Elhamid 2012 , Philipp Schenkel et al 2013, Tareq Al –Nemr et al 2016 ,Ayat 2016 and Tareq Al –Nemr et al 2017 Monira 2017). These differences in protein content between the full-fat Domiati cheese and low-fat Domiati cheeses may be attributed to their moisture content. Korish and Abd Elhamid 2012 Abeer 2013) cheeses made by full-fat milk or low-fat milk with fat replacer were within the normal composition range for Domiati cheese (Kebary et al. 2006; Ayad 2009 Treq El –Nemer et al 2016 and Ayat 2016).

Table (1): Chemical properties of low fat Domiati cheeses.

Item	TREATMENTS *											
	F			L			LS			LZ		
	Months											
	0	1	2	0	1	2	0	1	2	0	1	2
PH	5.8	4.9	4.4	6.0	5.2	4.5	5.5	4.5	4.0	5.1	4 .2	3.8
Moisture %	62.6	58.2	55.3	58.5	55.6	52.4	7.2	64.2	60.6	66.9	63.3	59.1
F/DM %	46.9	46.5	46.1	15.7	16.9	18.4	16.2	17.5	19.9	16.4	18.6	20.5
T.N/DM%	6.1	5.8	5.5	7.7	6.8	6.2	7.9	6.6	6.1	7.8	6.5	6.0

* F: Full fat cheese (control), L: Low fat cheese,

LS: Low fat cheese with simplesse resemble and LZ: Low fat cheese with Z-trim resemble

3- Ripening properties

Water soluble nitrogen (SN) and non protein nitrogen (NPN) of all cheese significantly increased ($P < 0.05$) as pickling period advanced Table (2). Similar results were found by El Abd et al (2000), Abd El Khader (2003), Kebary et al 2006, Ayat 2016 and Monira et al 2017.The increase was more pronounced after the first month than the second month .low fat cheese (L) had significantly the lowest SN which might be due to low moisture content which

in turn suppress the growth of proteolytic bacteria and also inhibit protease enzymes activity Kebary et al 2006 and Ayat 2016 .Addition of fat replacers caused significant increase in SN content($P < 0.05$).

Total volatile fatty acids (T .V.F.A) significantly increased ($P < 0.05$) after pickling storage period, Table (2). The same trend was found by Mehanna et al (2002) and Abd El Khader (2003).The first month showed higher increase in T .V.F.A than the second month. Results appeared that F cheese had higher (T .V.F.A) than L cheese. These may be due to the increase in moisture content which increase the water activity that stimulate the bacterial growth.

Cheese yield Table (2) significantly decreased ($P < 0.05$) as pickling progressed Mehanna et al (2002) and Abd El Kader (2003)the decrease during the first month was greater than the second month .L cheese recorded the lowest yield these may be due to the effect of fat of reducing whey synersis (Kebary et al 2006, Tareq al nemer 2016 , Ayat 2016 and Monira et al 2017).Cheese LS had the highest yield followed by F *cheese*

Table (2): Ripening properties of low fat Domiati cheeses made from milk containing a fat rep1acer during ripening at room temp.

Item	Treatment *											
	F			L			LS			LZ		
	Month											
	0	1	2	0	1	2	0	1	2	0	1	2
SN (%)	O.231	0.402	0.490	0.241	0.378	0.481	0.499	0.740	0.816	0.302	0.581	0.693
NPN (%)	0.058.	0,188	0,194	0,057	0,086	0.188	0.159	0.263.	0.302	0.068	0.219	0.268
T V.F.A 1ml 0.1N NaOH	11.8	15.6	17.6	9.8	13.8	15.4	12.3	18,6	20,8	10,8	16.2	18.4
Yield%	28.2	25.4	23.7	24.9	20.7	18.6	30.4	26.3	24.5	29.8	25.6	24.8

* See table 1 for details

3-Sensory evaluation

The means of sensory scores of all sensory attributes are given in Table (3). The addition of both fat replacers had a significant effect **($P < 0.05$)** on improving the appearance, flavor, body & texture of the low fat Domiati cheeses. LS cheese received approximately the same scores for body & texture, flavor and appearance of the full-fat cheese (control).

These results were in agreement with the finding of Ayat 2016 and Tareq Alnemr et al (2017).

Table (3): Organoleptic properties of low fat Domiati cheeses made from milk containing a fat rep1acers during ripening at room temp.

Item	Treatment *											
	F			L			LS			LZ		
	Month											
	0	1	2	0	1	2	0	1	2	0	1	2
Flavour 50 points	8	43	8	29	2	8	7	3	7	2	9	43
Body and texture 40 points	32	5	8	29	1	3	5	8	9	33	36	38
Appearance 10 points	8	9	9	6	7	7	8	9	10	7	8	9
Total : 100 points	78	87	95	64	70	78	80	90	96	2	83	90

* See table (1) for details.

4. Serum lipid assay

Serum lipid profile for rats fed on basal diets, full fat Domiati cheese diets and low fat Domiati cheese diets at the end of experimental period are presented in Table (4). It was clear that the highest cholesterol content was found to be in full fat Domiati cheese diets groups, while L,LS,LZ groups had lowest content of cholesterol. However., HDL values were not significantly affected ($p \leq 0.05$) by fat replacer. It was noticed that the highest TG content was found to be in rats fed on full fat Domiati cheese, the lowest TG was found to be in L, LS and LZ Domiati cheese. There were no significant differences in TG content between rat groups fed on low fat cheese control and rat groups fed on cheese with fat replacers The highest LDL was found to be in rat groups fed on full fat Domiati cheese diets. The lowest LDL was in rat groups fed on L, LS and LZ Domiati cheese. EL-Refai et al., (2011) reported that TG, total cholesterol and LDL were significantly affected by fat replacers level and not affected by the fat replacer type.

Table (4): Serum lipids profile of rats fed on low fat Domiati cheese made from milk containing a fat replacers.

Item	After four weeks				
	C *	F	L	LS	LZ**
Triglycerides	105	115	86	89	84
Cholesterol HDL	71	73	72	71	74
Cholesterol LDL	72	85	61.8	64.2	58.2
Total cholesterol	164	181	151	153	149
Atherogenic index	1.30	1.47	1.09	1.15	1.01

C: Rats feed on basal diets

* * See table (1) for details

The atherogenic index is an indicator for the susceptibility for atherosclerosis (Kawase *et al.*, 2000). Table (4) showed the atherogenic index for rats fed full fat and low fat cheese. These results indicated that the atherogenic index significantly ($p \leq 0.05$) decreased as a result of fat replacement.

The highest value in atherogenic index was found in F group and the lowest level in atherogenic index was found in LZ group. All low fat cheese had significant lower atherogenic index compared with full fat cheese group.

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