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# UTILIZATION OF ULTRAFILTRATED WHEY PROTEIN CONCENTRATE IN THE MANUFACTURE OF REDUCED FAT PROCESSED CHEESE SPREAD

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## ABSTRACT

The impact of ultrafiltrated whey protein concentrate (UF-WPC) on the compositional physical, organoleptical and biological attributes of reduced fat processed cheese spread (PCS) was aimed to study.

The basic blend of PCS (control) was planned to contain 41% dry matter (DM) and 45% Fat/DM using mature Ras cheese (as a supply of aroma as well as hydrolyzed protein) and skim milk powder (SMP), UF-WPC or the mixture of both of them (1:1, on dry basis) as additional source of milk solids not fat (ASMSNF) to provide blends with intact milk proteins. Butter was used to complete fat requirements. The butter quantities were lowered proportionally to achieve the designed reduction in the fat/DM content to be 30 and 15%. In the blends of SMP alone as ASSNF, Simplesse® was added to mimic the fat on the base of 1% fat could be replaced by 0.1% Simplesse®. Moreover, ascending level of emulsifying salt (ES) was added on the base of 22.5g ES for each 100g protein providing that the maximum ES level did not exceed the level of 4%. Furthermore, 1.2% cooking salt was added and the pH value of all blends was adjusted to 5.7 using 10% citric acid or $NaHCO_3$ solutions. Level of 0.01% of nisin was added. The cooking procedure was carried out at 85°C for 7 min. Further, a local reduced fat (light) PCS was used as a commercial control.

The obtained results show that the reduction in the fat content of PCS was associated with increase the protein and ash contents as well as cheese firmness as inversely indicated from the penetration value. Likewise, biological parameters of protein quality of PCS namely true digestability, biological value and net protein utilization were also improved whether by fat reducing or UF-WPC addition. Oil separation, meltability and organoleptic scores were declined due PCS fat reduction. The usage of UF-WPC raised the protein content and enhanced the appearance and the meltability of PCS, while the ash content of PCS was not influenced by UF-WPC addition.

As a conclusion, UF-WPC could be successfully used as ASSNF whether alone or in participation with SMP in reduced fat PCS making for recovering the fat deficiency and improving the sensory as well as the nutritional quality.

**Key words:** Reduced fat processed cheese - Whey protein concentrate, Simplesse® - Processed cheese properties.

## INTRODUCTION

Processed cheeses are among cheese verities appreciated by consumers. The Egyptian dairy industries produce about 130.000 ton per year CFI (2006). Processed cheese could be defined as the product obtained by cooking a blend of shreded naturally maturated cheese as partially hydrolyzed casein as well as flavouring source (maximum 20% of total blend protein) mixed with fresh and moderate cheese curd as a source of intact protein, namely casein (minimum 50% of total protein for spreadable type and 70% of block one). An emulsifying agent, colouring material and water with slowly continuous constant agitation or shearing, and then packaged while still hot (Meyer, 1973; Berger *et al,* 1989; Caric & Kalab, 1993; Fox *et al*, 2000 and Abd El-Salam *et al,* 2005). Other dairy or non dairy ingredients may be added to the blend.

Nevertheless, because of its relatively higher fat content processed cheese, particularly spreardable type, may be considered, from the nutritional viewpoint, as an unbalanced food, especially, when it used as a sole sandwich filling food for school children or even for adults. Moreover, the "Diet and Health" report by the National Research Council (NRC, 1989) states that, obesity is an

independent risk factor for many dangerous diseases. These facts distinguished the significance of fat reduction and consequently the increase of the need to develop dairy products to face the current upward trend in nutritional and health awareness.

Many fat replacers were tested for reducing calories in many dairy products and little for processed chesses (Kebary *et al,* 1998 & 2001 and Farahat, 1999). However, whey protein can play an un-neglectable role in this respect. Fayed (1986) reported that, the retention or incorporation of whey protein into low or skimmed milk cheese exhibited such fat-replacer behaviour recovering relatively the fat deficiency and helped products to regain their smoothness creaminess, palatability and mouthfeel attributes. Furthermore whey proteins are recognized as being highly superior to most other proteins in nutrition (Renner, 1983; Renner & Abd El-Salam, 1991 and Youssef *et al,* 2007).

The branch of whey proteins concentrate (WPC) is considered the main whey derivative and at the same time, the ultrafiltration (UF) technique offers almost the sole possibility of their concentration in the native form, by which their utilization scope could be extended. Whereas, several studies have been designed on their incorporation in many dairy products involving processed cheese (Jelen & Yehya, 1981; El-Sayed, 1987; Gupta & Reuter, 1992a; Abd El-Salam *et al,* 1996 and Al-Khamy *et al,* 1997).

The use of WPC in processed cheese leads to gain several technological and economical advantages. The use of such cheap ingredient namely WPC to replace the expensive cheese fat would reduce the production cost of processed cheese and offer a feasible way for WPC utilization. The high biological value of whey proteins would elevate the nutritional value of processed cheese containing WPC. Also the addition of WPC in processed cheese can modify the functional properties of the product for variable uses. Several reports showed the feasibility of WPC using in processed cheese and spreads (Kairukshtene, 1970; Georgakis, 1975; Salem *et al,* 1987; El-Neshawy *et al,* 1988 and Gab-Allah, 2004).

With that in view, the present study was aimed to experiment the incoroporation of the UF-WPC into reduced fat processed cheese spread (PCS) to find out to what extent it would maintain its attributes and sensory acceptance with emphasis on the biological aspects.

# MATERIAL AND METHODS

## Materials

Skim milk powder (SMP) made by Lactex in Poland, sweet whey powder (SWP) made in Holland, butter (82.5% fat) made in Denmark, mature Ras cheese made by Misr Milk, cooking salt produced by El-Nasr Saline's Co. and Food Co. at Cairo, emulsifying salt ($S_9$ special) made by JOHA BK Giulini Ladonburg Corporation, GmbH Germany, Simplesse 100® made by CPKeclo, Penrhyn Road, Knowsley Business Park, Denmark and nisin (nisaplin) made by Aplin & Barrettm Ltd., Yoevil, Somerst, England were obtained from the local market at Cairo. Further, local brand of low fat (light) processed cheese spread (PCS) was used as a commercial control. The composition of dairy ingredients used is presented in Table (1).

## 2. Experimental procedures

### Preparation of ultrafiltrated whey protein concentrate (UF-WPC)

Whey powder was firstly reconstituted at a rate of powder: water of 1:8 at 40 -50°C. After 15 min at this temperature, the reconstituted whey could be used whereas a complete hydration was occurred as recommended by Nowstead *et al* (1979) and Fayed (1986). Then, it was heated to 75°C for 15 sec, cold immediately to 5 °C and rewarmed to50°C at which the UF process was run as recommended by Maubois *et al*, (1971) using a CARBOSEP UF-unit (type 2S 37,France) with zirconium-oxide membrane area of 1.68 $m^2$ to about 30% total solids at the Lab. of the Agriculture secondary school at Giza. The composition of resultant UF-WPC is presented in Table (1).

**Table (1): Gross composition of commercial control light processed cheese spread (PCS) and dairy ingredients.**

| Component % | Local control PCS | Dairy ingredient | | | |
|---|---|---|---|---|---|
| | | SMP | SWP | Ras cheese | UF-WPC |
| Dry matter (DM) | 36.35 | 95.50 | 96.56 | 69.70 | 29.80 |
| Protein/DM | 33.41 | 36.75 | 12.42 | 52.87 | 60.03 |
| Fat/DM | 25.03 | 1.05 | 1.04 | 42.85 | 6.40 |
| Lactose*/DM | 27.48 | 55.0 | 77.96 | - | 29.37 |
| Ash/DM | 14.08 | 7.20 | 8.58 | 4.28 | 4.20 |

SMP: Skim milk powder SWP: Sweet whey powder
UF-WPC: Ultrafiltrated whey protein concentrate *Calculated by difference

**Preparation of PCS with descending fat content**

The basic blend of processed cheese spread (control) was planned to contain 41% dry matter (DM) and 45% Fat/DM according to EOSQ (2005) using mature Ras cheese and SMP, UF-WPC or the mixture of both of them (1:1, on their dry basis) as additional source of milk solids not fat (ASMSNF) for the experimental processed cheese spread at suitable level as recommended by Meyer (1973).

Butter was used to complete fat content requirements. The butter quantities were lowered proportionally to achieve the designed reduction in the fat content to be 30 or 15% fat/DM (Table, 2). In the blends of SMP alone as ASMSNF, Simplesse® was added to mimic the fat on the base of 1% fat could be replaced by 0.1% Simplesse® . Moreover , ascending level of emulsifying salt ( ES ) was added on the base of 22.5g ES for each 100g protein providing that the maximum ES level did not exceed the level (4%) permitted by EOSQ ( 2005 ) (Table, 2). Furthermore, 1.2% NaCl was added and the pH value of all blends was adjusted to 5.7 as recommended by Meyer (1973) using 10% citric acid or $NaHCO_3$ solutions. Level of 0.01% of nisin (as preservative agent) was added. Also, the preparations of the initial ingredients and cooking procedure were carried out as described by Meyer (1973) at 85°C for 7 min. using a double jacket pan with a batch capacity of 2.0 kg and stirring velocity of 120-140 r.p.m. Thereafter, the resultant cheese spreads were filled into glass jars (200 g), airtightly closed and cold stored for analysis. Three replicates were carried out for each treatment.

**Table (2): The blend formulas (kg/ 100 kg) for processed cheese spread (PCS) as affected by both of alternative fat substitution with ultrafiltrated whey protein concentrate (WPC) *vis a vis* Simplesse® and the kind of the additive source of solids not fat (SNF).**

| | PCS treatments | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| SNF source | SMP | | | WPC | | | SMP/WPC (1:1) | | |
| Fat/DM% | 45% | 30% | 15% | 45% | 30% | 15% | 45% | 30% | 15% |
| Ingredients : Mature Ras cheese (70% DM, 30% fat) | 19.3 | 19.3 | 19.3 | 19.3 | 19.3 | 19.3 | 19.3 | 19.3 | 19.3 |
| Butter (82% fat) | 14.91 | 7.56 | -- | 14.91 | 7.56 | -- | 14.91 | 7.56 | -- |
| SMP (96% DM) | 12.27 | 12.77 | 22.8 | -- | -- | -- | 5.85 | 8.91 | 11.9 |
| WPC (30% DM) | -- | -- | -- | 35.8 | 55.0 | 75.5 | 18.7 | 28.5 | 38.1 |
| Salt | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 |
| Emulsifying salt | 2.5 | 2.87 | 3.6 | 3.6 | 4.0 | 4.0 | 3.05 | 3.44 | 3.8 |
| Simplesse® | -- | 0.615 | 1.23 | -- | -- | -- | -- | -- | -- |
| Nisin | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Water | 49.81 | 50.67 | 51.86 | 25.18 | 12.93 | 0.0 | 36.98 | 31.8 | 25.69 |

DM: Dry matter SMP: Skim milk powder

**Analytical methods**

Contents of dry matter, nitrogen, fat and ash were determined as reported by AOAC (2000). The pH value was measured electrometrically using Lab. pH meter with a glass electrode, Hanna model 8417. Penetration value was measured as described by Bourne (1982). Oil separation index was determined according to Thomas (1973). Meltability was measured using the meltability test apparatus as described by Olson and Price (1958) and modified by Savello *et al* (1989).

Biological assay was carried out as described by Schiller (1960) and modified by Horszczaruk & Bock (1963) using Albino male rats weighing of 70-75g.

Ten different diets were previously prepared according to the composition of the diet of Eggum (1973) for the 10 subjected experimental animal groups. The parameters of the protein quality, namely true digestibility (TD), biological value (BV) and net protein utilization (NPU) for samples which evaluated biologically *via* the corresponding 10 rats groups were calculated individually according to Eggum (1973).

Organoleptic properties of processed cheese spread were evaluated according to scheme of Meyer (1973). The obtained data were statistically analyzed according to statistical analyses system user's guide (SAS, 1998).

## RESULTS AND DISCUSSION

**Chemical composition**

The obtained results (Table 3) reveal that, the dry matter content of any PCS was nearly the same regardless the kind of ASSNF used. Although the absence of UF-WPC, the presence of Simplesse® in the samples containing only SMP improved the water holding capacity of resultant PCS against the moisture loss during the cooking process step.

The fat content decreased in the PCS blends according to the designed fat content. The ash content of PCS was raised significantly as the fat content was decreased. However, the statistical analysis did not detect any significant variation between SMP-samples and the others in respect to the ash content criterion. It worthy to mention that the commercial control PCS possessed dry matter content lower than

treatments. While, all its components other than DM are in the normal range of reduced fat PCS, (Table, 3).

**Table (3): Chemical composition of processed cheese spread (PCS) as affected by both of alternative fat substitution with ultrafiltrated whey protein concentrate (WPC) *vis a vis* Simplesse® and the kind of the additive source of solids not fat (SNF).**

| SNF source Fat/DM% | PCS treatments | | | | | | | | | Local control PCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | SMP | | | WPC | | | SMP/WPC (1:1) | | | |
| | 45% | 30% | 15% | 45% | 30% | 15% | 45% | 30% | 15% | |
| Component: DM % | $41.96^{a,a}$ | $41.77^{a,a}$ | $41.12^{a,b}$ | $41.31^{a,a}$ | $41.17^{a,a}$ | $41.13^{a,b}$ | $41.97^{a,a}$ | $41.43^{a,a}$ | $41.32^{a,b}$ | $36.35^{b,c}$ |
| Protein % | $8.70^{c,c}$ | $10.60^{c,b}$ | $12.30^{c,a}$ | $13.50^{a,c}$ | $18.30^{a,b}$ | $23.40^{a,a}$ | $11.70^{b,c}$ | $14.70^{b,b}$ | $18.10^{b,a}$ | $12.14^{c,c}$ |
| Fat % | $18.90^{a,a}$ | $12.60^{a,b}$ | $6.10^{a,c}$ | $18.50^{a,a}$ | $12.30^{a,b}$ | $6.20^{a,c}$ | $18.90^{a,a}$ | $12.30^{a,c}$ | $6.20^{a,c}$ | $9.0^{a,bc}$ |
| Ash % | $4.821^{a,c}$ | $5.321^{a,b}$ | $6.321^{a,a}$ | $5.173^{a,c}$ | $5.621^{a,b}$ | $5.633^{a,a}$ | $5.017^{a,c}$ | $5.513^{a,b}$ | $5.837^{a,a}$ | $5.117^{a,c}$ |

DM: Dry matter SMP: Skim milk powder

The letters before comma possess the factor of SNF sources. While those after comma possesses the factor of designed percentages of Fat/DM. The means with the same letter at any position did not significantly differ (P>0.05).

## Physical properties

The penetration value of PCS was lowered and consequently the firmness was raised as the fat content decreased. Moreover, the use of UF-WPC as ASSNF yielded in a significant strengthening in the PCS firmness as reflected from the penetration values given in Table (4).

**Table (4): Physical properties of processed cheese spread (PCS) as affected by both of alternative fat substitution with ultrafiltrated whey protein concentrate (WPC) *vis a vis* Simplesse® and the kind of the additive source of solids not fat (SNF).**

| SNF source Fat/DM% | PCS treatments | | | | | | | | | Local control PCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | SMP | | | WPC | | | SMP/WPC (1:1) | | | |
| | 45% | 30% | 15% | 45% | 30% | 15% | 45% | 30% | 15% | |
| Penetration (mm) | $22.5^{a,a}$ | $21.1^{a,b}$ | $19.0^{a,c}$ | $19.0^{c,a}$ | $18.5^{c,b}$ | $17.0^{c,c}$ | $21.0^{b,a}$ | $19.0^{b,b}$ | $19.0^{b,c}$ | $19.4^{a,c}$ |
| Oil separation index | $72.0^{a,a}$ | $32.0^{a,b}$ | $7.0^{a,c}$ | $60.0^{a,c}$ | $25.0^{c,b}$ | $5.0^{c,c}$ | $15.0^{b,a}$ | $30.0^{b,b}$ | $5.0^{b,c}$ | $11.0^{b,a}$ |
| Meltability % | $100^{a,a}$ | $90.0^{a,b}$ | $55.0^{a,c}$ | $17.0^{c,a}$ | $14.0^{c,b}$ | $9.0^{c,c}$ | $23.0^{b,a}$ | $17.0^{b,b}$ | $13.0^{b,c}$ | $15.0^{b,b}$ |

DM:Dry matter SMP: Skim milk powder

The letters before comma possess the factor of SNF sources. While those after comma possess the factor of designed percentages of Fat/DM. The means with the same letter at any position did not significantly differ (P>0.05).

Concerning the oil separation index of PCS, it was significantly associated with the proportional reduction in the cheese fat content (Table 4). Likewise, the use of UF WPC improved the emulsion stability as inversely indicated from the oil separation index.

Regarding the meltability % of PCS, there was significant reduction in this criterion positively related either to the fat content, or SMP *versus* UF-WPC portion (Table, 4).

**Organoleptic quality**

The sensory scoring (Table 5) indicates that, with addition of SMP solids the cheese appearance score was decreased as the cheese fat content was lowered. The adjustment of cheese colour by adding colouring agent might be needed. However, the appearance score was significantly enhanced due to the use of UF-WPC whether in participation with SMP or alone.

Although the reduction in the fat content led to significant reduction in the PCS consistency score, the use of UF-WPC in participation with SMP improved the PCS consistency as indicated from the significant increase in the sensory score of cheese consistency (Table 5).

**Table (5): Organoleptic scores of processed cheese spread (PCS) as affected by both of alternative fat substitution with ultrafiltrated whey protein concentrate (WPC) *vis a vis* Simplesse® and the kind of the additive source of solids not fat (SNF).**

| SNF source Fat/DM% | PCS treatments | | | | | | | | | Local control PCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | SMP | | | WPC | | | SMP/WPC (1:1) | | | |
| | 45% | 30% | 15% | 45% | 30% | 15% | 45% | 30% | 15% | |
| Property: Appearance (20) | $20^{b,a}$ | $18^{b,b}$ | $16^{b,c}$ | $20^{a,a}$ | $20^{a,b}$ | $20^{a,c}$ | $20^{a,a}$ | $20^{a,b}$ | $20^{a,c}$ | $20^{a,a}$ |
| Consistency (40) | $39^{b,a}$ | $25^{b,b}$ | $25^{b,c}$ | $37^{b,a}$ | $35^{b,b}$ | $30^{b,c}$ | $38^{a,a}$ | $38^{a,b}$ | $35^{a,c}$ | $39^{b,a}$ |
| Flavour (40) | $39^{c,a}$ | $37^{c,b}$ | $30^{c,c}$ | $38^{b,a}$ | $35^{b,b}$ | $35^{b,c}$ | $36^{a,a}$ | $38^{a,b}$ | $38^{a,c}$ | $37^{c,b}$ |
| Total score (100) | $98^{c,a}$ | $80^{c,b}$ | $71^{c,c}$ | $95^{b,a}$ | $90^{b,b}$ | $85^{b,c}$ | $94^{a,a}$ | $96^{a,b}$ | $93^{a,c}$ | $96^{a,b}$ |

DM: Dry matter SMP: Skim milk powder

The letters before comma possess the factor of SNF sources. While those after comma possesses the factor of designed percentages of Fat/DM. The means with the same letter at any position did not significantly differ (P>0.05).

The cheese flavour which declined by lowering the fat content (Table 5), was restored by adding UF-WPC in participation with SMP.

The overall sensory scores confirm the previous observations regarding the different organoleptic attributes, where the score decreased as the PCS fat content was lowered and increased when UF-WPC was added especially in participation with SMP, (Table, 5). Fayed (1986); Abd El-Salam *et al* (1996); Al-Khamy *et al* (1997) and Abd El-Salam *et al* (2005) reported that the retention or incorporation of whey protein into low- fat or skimmed-milk cheese plays, relatively

a fat mimetic role recovering some of the fat deficiency and helps the products to regain their smoothness, creaminess, palatability and mouthfeel attributes. Likewise, Thapa & Gupta, (1990); (1992a & b); (1996) and Gupta & Reuter (1990); (1992a & b); (1993) confirmed that UF-WPC addition imparted milder flavour to the cheese foods

**Nutritional aspects**

Concerning the nutritional quality of PCS as indicated from the biological parameters given in (Table, 6), it could be noticed that the TD and BV% of PCS was significantly ($P<0.001$) improved whether by reducing the fat content or/and UF-WPC utilization. Forsum & Hambraneous (1977) and Tolboe (1982) reported that the TD of WPCs has been found to be 97-100%. Another reason could be attributed to the relatively low lactose content in UF-WPC *versus* SMP, (Table, 2). Forsum (1975 a & b) declared that, the TD% decreases with increased dietary lactose content. Moreover, Buchhein *et al* (1986 & 1988) reported that if the casein/ whey protein ratio is changed from 80: 20 that found in normal case to 40: 60 by adding WPC, the protein shows a different coagulation behaviour in the stomach: because of the reduced proportion of casein the formation of a very firm and only slowly decomposable coagulum is inhibited and the passage of the milk through the stomach is markedly enhanced. Renner (1983) and Renner & Abd El-Salam (1991) reported that the BV% of whey protein is 104 higher than even the standard protein (egg protein), however, the combination of whey protein and casein produces a dispropotionate increase in the nutritional value.

**Table (6): Nutritional protein properties of processed cheese spread (PCS) as affected by both of alternative fat substitution with ultrafiltrated whey protein concentrate (WPC) *vis a vis* Simplesse® and the kind of the additive source of solids not fat (SNF).**

| SNF source | PCS treatments | | | | | | | | | Local control PCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | SMP | | | WPC | | | SMP/WPC (1:1) | | | |
| Fat/DM% | 45% | 30% | 15% | 45% | 30% | 15% | 45% | 30% | 15% | |
| TD % | $92.12^{c,b}$ | $92.84^{c,ab}$ | $94.21^{c,a}$ | $94.91^{a,b}$ | $98.06^{a,ab}$ | $99.18^{a,a}$ | $95.39^{b,b}$ | $95.77^{b,ab}$ | $96.12^{b,a}$ | $93.64^{c,ab}$ |
| BV % | $71.35^{c,c}$ | $74.81^{c,b}$ | $80.01^{c,c}$ | $78.99^{a,c}$ | $86.01^{a,b}$ | $92.19^{a,c}$ | $78.65^{b,c}$ | $80.79^{b,b}$ | $85.99^{b,c}$ | $77.14^{b,c}$ |
| NPU % | $65.73^{c,c}$ | $69.48^{c,b}$ | $75.43^{c,a}$ | $74.97^{a,c}$ | $84.37^{a,b}$ | $91.43^{a,a}$ | $75.02^{b,c}$ | $77.37^{b,b}$ | $82.65^{b,a}$ | $72.23^{c,a}$ |

DM: Dry matter SMP: Skim milk powder

TD: True digestibility BV: Biological value NPU: Net protein utilization

The letters before comma possess the factor of SNF sources. While those after comma possesses the factor of designed percentages of Fat/DM. The means with the same letter at any position did not significantly differ ($P>0.05$).

Logically, the NPU% (Table 6), which was the multiplication yield of both TD x BV was also increased as the fat content decreased and/or as the portion of UF-WPC in PCS raised. Similar trends were reported by Youssef *et al* (2007) towareds yoghurt fortified with WPC.

As a conclusion, UF-WPC could be successfully used as ASSNF whether alone or in participation with SMP in reduced fat PCS making for recovering the fat deficiency and improving the sensory and nutritional quality.

## REFERENCES

Abd-El-Salam, M.H.; A.F. Al-Khamy; G.A. El-Garawany; A. Hamed and A. Khader (1996). Composition and reological properties of processed cheese spread as affected by the level of added whey protein concentrates and emulsifing salt. Egypt. J. Dairy Sci., 24: 309-322.

Abd-El-Salam, M.H; S. El-Shibiny and N.S. Ahmed (2005). Studies on processed cheese spreads in Egypt. A review. Egypt. J. Dairy Sci., 33: 129-141.

Al-Khamy, A.F; G.A. El-Garawany; A. Khader; A. Hamed and M.H. Abd-El-Salam (1997). The use of whey protein concentrates in processed cheese spreads. Egypt. J. Dairy Sci., 26: 151-159

AOAC (2000).Association of Official Analytical Chemists. Official Method of Analysis. 25th Ed., Benjamin Franklin Station, Washington, USA.

Berger, W.; H. Klostermeyer; K. Merkenicl and G. Uhlmann (1989). In: Processed Cheese Manufacture. A Joha® Guide BK Ladenburg Gmb H, Gesellschaft fuer chemische Erzeugnisse, Ladenburg, Germany.

Bourne, M.C. (1982). In: Food Texture and Viscosity Concept and Measurement. pp. 544-546.Academic Press Inc., New York, USA.

Buchhein, W; K.H.Peters and W. Kaufmann (1986). Technological, physico- chemical and sensoric aspects of milk and cultured milk with a modified casein: whey protein ratio. Milchwissenschaft-. 1986; 41: 139-141

Buchhein,W.; H. Frister; H. Hagemeister; H. Meisel; M. Pfeuffer and K.E. Scholz-Ahrens (1988). Deut. Molk. Ztg.,1988, 109, 800.

C.F. Renner, E.&Abd EL-Salam, M.H. (1991). IN: Application of Ultrafiltration in the Dairy Industry.1st Ed., Elssevier Applied Science, Elssevier Science Publishers, LTD. Essex, England.

Caric, M. and M. Kalab (1993). Processed Cheese Products. In: Cheese Chemistry Physics, and Microbiology. PP 467-505. 2nd Ed, ed by Fox, P. F., Major Cheese groups, Chapman Hall Ltd, London, UK.

CFI (2006). Chamber of Food Industries. Annual Report, Cairo .

EOSQ (2005). Egyptian Orgnization for Standards and Quality. Processed cheese. Part 2: Spreadable processed cheese, Egyptian Standard (ES) 999/2005.

Eggum, B.O. (1973). A Study of Certain Factors Influencing Protein Utilization in Rats and Pigs.pp. 17-21. Ph.D. Thesis, Institute of animal Science and Royal veterinary and Agriculture Univ., Copenhagen.

El-Neshawy, A.A.; S.M. Farahat and H.A. Wahbah (1988). Production of processed cheese food enriched with vegetable and whey proteins. Food Chem., 28: 245-255.

El-Sayed, M.M. (1987). The Use of Ultrafiltration Technique for The Utilization of Cheese Whey. pp. 23-43. Ph. D. Thesis, Fac. Agric., Ain Shams Univ. Cairo.

Farahat, A.M. (1999). Production of Some Special Dairy Products. pp. 40-60. M. Sc. Thesis, Fac. Agric., Ain Shams Univ., Cairo.

Fayed, A.E. (1986). Protein Fortification of some Dairy Products. pp.35- 50. Ph.D. Thesis, Fac. Agric., Ain Shams Univ. Cairo.

Forsum, E. (1975a). Use of a whey protein concentrate as a supplement to maize, rice and potatoes: a chemical and biological evaluation using growing rats. J. Nutr., 105: 147-153.

Forsum, E. (1975b). Effect of dietary lactose on nitrogen utilization of a whey protein concentrate and its corresponding amino acid mixture. Nutr. Reports Int., 11: 419-428.

Forsum, E. and L. Hambraeus (1977). Nutritional and biochemical studies of whey products J. Dairy Sci., 60: 370-377.

Fox, P.F.; T.P. Guinee; T.M. Cogan and P.L.H. McSweeney (2000). In: Fundamentals of Cheese Science. pp. 450-525. An Aspen Pub., Gaithersburg, Maryland, USA.

Gab-Allah, R.H. (2004). Utilization Whey Derivatives in Some Dairy Products. pp. 22- 45. M. Sc. Thesis, Fac. Agric., Ain Shams Univ. Cairo.

Georgakis, S.A. (1975). Concentration of whey protein by UF and its use for processed cheese manufacture. Proc. of the 20th World Veterinary Congr. 6-12 Jul. C. F. DSA 40:1255 (1978).

Gupta, V.K. and H. Reuter (1990). Processed cheese foods incorporated with whey protein concentrates. Brief Communications of the XX111 Int. Dairy Cong., Montréal, Vol. 11: 508.

Gupta, V.K. and H. Reuter (1992a). Processed cheese foods with added whey protein concentrates. Lait-Lyon. 1992; 72: 201-212.

Gupta, V.K. and H. Reuter (1992b). Protein solubility and gelation behaviour of whey protein concentrates prepared by ultrafiltration of sweet cheese whey. Neth. Milk and Dairy J., 46: 89-100

Gupta, V.K. and H. Reuter (1993). Firmness and melting quality of processed cheese foods with added whey protein concentrates. Lait. 73: 381-388.

Horszczaruk, F. and H.D. Bock (1963). Eine modification des von K. Schiller vorgesschlagene Stoffwechselkafig fuer Ratten. Ztschr. Versuchstierk. 2:126-131.

Jelen, P. and N. Yehya (1981). Utilization of cottage cheese whey in processed cheese-like dariy spreads. Egypt. J. Dairy Sci., 9:159-170.

Kairyukshtene, I. (1970). Most frequently used emulsifying salts for processed cheese and some of their properties. Syroden. Prom. 5:139-540 C.F. DSA, 33:2791.

Kebary, K.M.K.; A.M. Abeid and R.M. Badawi (1998). Impact of fat replacers on properties of low fat processed cheese spread. Proc. 7th Egypt. Conf. Dairy Sci.& Technol., 383-401.

Kebary, K.M.K.; S.A. Hussein and R.M. Badawi (2001). The use of whey proteins in flavoured low fat processed cheese spread. Proc. 8th Egypt. Conf. Dairy Sci.& Technol., 369-381.

Maubois, J.L.; G. Mocquot; J.L. Thapon; M. C. Humilier; A. Chopin; H. Goudedranche; C. Dupas; E. Blanc-Patin; M. Piot and J. Fauquant (1971). Preparation of cheese from a concentrate obtained by ultrafiltration of milk. Lait, 51: 495-533.

Meyer, A. (1973). Processed Cheese Manufacture. pp. 30-276. 1st Ed. Food Trade Press. Ltd., London, UK.

Nowstead, D.E.; A.Goldmann and J.G. Zadov (1979). Recombined milk and cream. Bull. Int. Dairy Federation Doc. 116: 7-13.

NRC. (1989). National research Council. In: Diet and Health Implications for Reduction Chronic Disease Risk. Common Health Food and Nutr. Board, Commission on life Sciences, Nat. Res. Council., National Academey Press, Washington, D. C., USA.

Olson, N. F. and W. V. Price (1958). A melting test for pasteurized process spreads. J. Dairy Sci., 41:999-1000.

Renner, E. (1983). In: Milk and Dairy Products in Human Nutrition. pp. 90- 256. W-GmbH, Volksw. Verlag, Munich, Germany.

Renner, E. and Abd El-Salam M.H. (1991). In: Application of Ultrafiltration in the Dairy Industry. pp. 139-289. Elsevier App. Sci. Pub., London and New York..

Salem, S.A.; Salam, A.E. and Gouda, E. (1987). Improvement of chemical rheological and organoleptic properties for local low fat processed cheese. Egypt. J. Dairy Sci., 15:263-271.

SAS (1998). Statistical Analysis System. SAS users Guid: Statistics. SAS Inst. Inst. Inc. Ed., Cary , Nc. USA.

Savello, P. A.; Ernstrom, C. A. and Kalab, M. (1989): Microstructure and meltability of model processed cheese made with rennet and acid casein. J. Dairy Sci. 72: 1-11

Schiller, K. (1960). Ein Stoffwechselkafig fur Ratten. Ztschr. Tierphysiol. Tierernarung futtermittelk. Futtermittelk. 15: 305.

Thapa, T.B. and Gupta, V.K. (1990). Shelf life of processed cheese food prepared with added whey protein concentrates. Brief Communication of the XXIII Int. Dairy Congr., Montreal, 8-12, Vol. II.539

Thapa, T.B. and Gupta, V.K. (1992a). Changes in sensoric and rheological characteristics during storage of processed cheese foods prepared with added whey protein concentrates. Indian J. Dairy Sci., 45: 140-145.

Thapa, T.B. and Gupta, V.K. (1992b). Rheological of processed cheese foods with added whey protein concentrates. Indian J. Dairy Sci., 45: 88-92.

Thapa, T.B. and Gupta, V.K. (1996). Chemical and sensory qualities of processed cheese foods prepared with added whey protein concentrates. Indian J. Dairy Sci., 49: 129-137.

Thomas, M.A. (1973). The use of hard milk fat fraction in processed cheese. Aust. J. Dairy Technol., 28: 77-80

Tolboe, O. (1982). Nutritional applications of whey protein concentrates in food products. Bull. Int. Dairy Federation. 147: 19-21.

Youssef, M.H.; Masoud, M.S. and Fayed, A.E. (2007). Biological evaluation of cow's milk yoghurt fortified with different source of milk proteins. Ann. Agric. Sci., Ain Shams Univ., Cairo, 52:165-175.

# الاستفادة من بروتينات الشرش المركزة بالترشيح الفائق في صناعة مفرود الجبن المطبوخ منخفض الدهن

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أستهدف البحث دراسة تأثير استخدام بروتينات الشرش المركزة بالترشيح الفائق على الخواص التركيبية، الطبيعية والحسية والحيوية لمفرود الجبن المطبوخ منخفض الدهن.

تم تصنيع مفرود الجبن المطبوخ على أساس نسبة 41% جوامد كلية و45% دهن فى المادة الجافة باستخدام جبن الراس التام التسوية بالإضافة إلى اللبن الفرز المجفف أو مركز بروتينات الشرش أو خليط منهما (1:1، على أساس المادة الجافة) كمصدر إضافى لجوامد اللبن اللادهنية، واستخدم الزبد لتزويد الخليط بالدهن اللآزم للمستويات المخطط لها لتكون 30 و15% فى المادة الجافة. أستخدم البديل الدهنى سمبلس Simplesse® لتعويض خفض نسبة الدهن على أساس أن كل 1% دهن يعوضها 0.1% من البديل الدهني وذلك في الخلطات التى لا تحتوى على مركز بروتينات الشرش (أى التي زودت باللبن الفرز المجفف فقط) كما تم زيادة نسبة ملح الاستحلاب طردياً مع زيادة نسبة البروتين في الخلطة على أساس أن كل 100 جرام بروتين يلزمها 22.5 جرام ملح إستحلاب بحيث لا تتجاوز النسبة المقررة بالمواصفات المصرية وهى 4% كحد أقصى. كما تم إضافة 1,2 %ملح طعام وضبط pH الخلطات إلى 5.7 باستخدام محلول 10% حمض ستريك أوبيكروبونات الصوديوم وأضيف المضاد الحيوي نيسين بنسبة 1.,. % وتم الطبخ على درجة 85°م لمدة 7 ق. كما تم مقارنة النتائج مع عينة تجارية محلية من مفرود الجبن المطبوخ منخفض الدهن.

ولقد أوضحت النتائج أن معاملات مفرود الجبن المطبوخ مخفض دهن كانت ذات محتوى أعلى من البروتين والرماد وبالتالى زيادة درجة الصلابة ، كما زادت جودة البروتين التغذوية ممثله في معدل الهضم والقيمة الحيوية وصافي الاستفادة من النتروجين . بينما انخفض معدل انفصال الدهن والقابلية للإنصهار وكذلك درجات تحكيم جميع الخواص الحسية وذلك بانخفاض نسبة الدهن في مفرود الجبن الناتج. كما أدى إستخدام مركز بروتينات الشرش إلى زيادة نسبة البروتين وتحسين مظهر وطعم الجبن الناتج علاوة على تحسين جميع دلالات جودة البروتين التغذوية في حين أنها لم تؤثر في محتوى مفرود الجبن من الرماد. وعلى ذلك فإن استخدام مركز بروتينات الشرش في صناعة مفرود الجبن المطبوخ منخض الدهن يعمل على تعويض بعض الخواص الطبيعية والحسية التي افتقدها بخفض الدهن علاوة على تحسين خواص الناتج التغذوية.

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