10th Conf. Agric. Dev. Res., Fac. Agric., Ain Shams Univ., Cairo, Egypt, 2006
Annals Agric. Sci., Sp. Issue, 1, 99-109, 2006

PRODUCTION OF LIGHT CALORIE WHIPPED CREAM USING MIMETIC FATS AND STEVIOSIDE

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ABSTRACT

Light calorie whipped cream was aimed to experiment in relation to its chemical physical, rheological and organoleptic properties. Whipping cream (WGC) base blend consisted of 41% total solids (TS), 35% fat, 0.01% Stevioside and 0.3% sodium carboxy methyl cellulose using fresh cream (50% fat) and skim milk (9% TS). To produce reduced calorie WGC, fat content was lowered to 25 and 15% depending on the use of Simplesse, Slendid or their mixture (1:1) to mimic milk fat on the base of 0.1% fat mimetic is instead of 1.0% fat. Dried whey protein concentrate (95% TS) was used to overcome the loss occurred in the TS content due to the reduction in the fat content to remain as in the control (41%). All WGC blends were homogenized at 55-60°C, heat treated at 74°C/ 30 sec. and aged for 24 h at 5±1°C, at which the whipping was carried out using superhand mixture at the maximum speed. The results indicated that, the protein, carbohydrate, ash and titratable acidity contents of WGC increased as the fat was replaced, while pH and caloric values decreased. Gradual increase in the consistency coefficient was occurred as the fat was mimiced, especially with Slendid, which caused also higher yield stress *vis a vis* Simplesse. Whipping time was prolonged by Simplesse, shortened by Slendid and unchanged by their mixture. Overrun % was harmed by Slendid and slightly reduced by Simplesse or both mixture. Neither leakage nor slipping was detected in the whipped cream along 24 h at 5±1°C. The fat replacement with slendid- simplesse mixture led to impart the 25%-fat WGC the highest sensory scores (98% of the control) followed by that mimiced by Simplesse alone (97% of the control). The corresponding scores in the case of 15% - fat WGC were 93 and 92%, respectively.

Key words: Slendid, Simplesse, Calorie value, Yield stress, Whippability

INTRODUCTION

Whipped cream is one of the favorite dairy products and an important ingredient in the confectionary products. It is suitable for serving with fruit and widely used as topping or filling, especially when mixed with suitable stabilizers, for desserts, pastries, cakes and ice cream. Whipped cream, should be firm enough to have an adequate rigidity to be handled, albeit with some care, and will

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(Received May 8, 2006)
(Accepted May 30, 2006)

maintain its shape for many hours or even days if suitably stored. Whipped cream should be also a stable foam in which air bubbles are entrapped in a mesh of serum and fat (**Arbuckle, 1986; Prentice, 1992; Ghita *et al* 1992 and Khalifa and Mansour, 1993**).

With the current upward trend in nutritional and health awareness, the consumer's demand for reduced or low calorie food has been accelerating (**Coninck, 1996**). But, according to the statement of **Tharp and Gottemoller (1990)** who mentioned that, a product must provide at least one-third fewer calories than the reference product to be qualified as "reduced calorie". That will be achieved only depending on the substitution of some components of whipped cream other than protein which is not allowed to be replaced for calorie reduction.

Several treatments have been tried to produce whipped cream with modified composition and properties and offered some possibilities for developing whipped cream with lower fat and higher protein than normal with prospectively comparable properties to that of good quality regular one (**Mann, 1985; Scurlock, 1987; Abd El-Salam *et al* 1993 and Salama *et al* 1995**). But until now, neither fat mimetics nor sugar substitutes were experimentally applied in its manufacture, therefore, the evaluation of some fat mimetics as well as the natural intense sweetener stevioside in the manufacture of light calorie whipped cream in relation to its attributes was aimed to carry out.

MATERIAL AND METHODS

Materials

Fresh buffalo's milk was obtained from the herd of Faculty of Agriculture, Ain Shams University, Egypt. Dried whey protein concentrate (consisted of 95% dry matter, 68% protein, 14% lactose, 12% ash and less than 0.5% fat) made by SFK DATABIAD, Hvidovre and Viborg, Denmark, was obtained from the local market. Simplesse 100® (modified dairy whey protein concentrate) made by CPKelco, Penrhyn Road, Knowsley Business Park, Denmark and Slendid 200® (type of high ester pectin) made by Copenhagen Pectin A/S DK, lille Skenseved, Denmark, both fat mimetics were obtained from the Egyptian Office for Trading and Agencies (eta), Cairo. Intense sweetener "Stevioside" with a purity of >98% was obtained from the International Association of Stervia Research Union, Stuttgart, Germany. Sodium carboxy methyl cellulose (CMC), made by BDH Chemical Ltd Poole; England, was obtained from the local market.

Experimental procedure

1. Cream separation

Fresh cream (54.5% total solids and 50% fat) was mechanically separated from fresh buffalo's milk.

2. Preparation of whipping cream blend

Whipping cream (WGC) base blend consisted of 41% total solids (TS), 35% fat, 0.01% stevioside and 0.3% CMC was made using the obtained fresh cream and liquid skimmed milk (9% TS). To produce reduced calorie WGC, fat content was lowered to 25 and 15% depending on the addition of Slendid, Simplesse or their mixture (1:1) to mimic milk fat on the basic of 0.1% fat mimetic is instead of

1.0% fat. Dried whey protein concentrate (DWPC) was used as bulking agent to overcome the loss occurred in the TS content due to the reduction in the fat content (Table, 1).

Table 1. The formulas (kg/100 kg) of lowered calorie whipping cream blends using fat mimetic and intense sweetener

Ingredient	Designed fat content		
	35%	25%	15%
Cream (54.5% TS, 50% fat)	70.00	50.00	30.00
Skim milk (9% TS)	29.69	39.03	48.66
Fat mimetic*	0.00	1.00	2.00
DWPC (95% TS)	0.00	9.66	19.03
Stevioside	0.01	0.01	0.01
CMC	0.30	0.30	0.30

DWPC : Dried whey protein concentrate
* Simplesse, Slendid or both mixture (1:1)
CMC : Sodium carboxy methyl cellulose

The quantities of DWPC and liquid skimmed milk required for WGC blends were calculated by fitting their compositions to the following suggested two equations:

$$ABTS = ACF + ACSNF + ALTS + AWTS + ANDAS \quad (1)$$

$$BQ = CQ + LQ + WQ + NDAQ \quad (2)$$

Where:

ABTS : Amount of total solids desired in the blend
ACF : Amount of fat obtained from the cream
ACSNF : Amount of solids not fat obtained from the cream
ALTS : Amount of total solids obtained from the liquid skimmed milk
AWTS : Amount of total solids obtained from dried whey protein concentrate
ANDAS : Amount of solids obtained from non dairy additives
BQ : Blend quantity
CQ : Cream quantity
LQ : Quantity of liquid skimmed milk
WQ : Quantity of dried whey protein concentrate
NDAQ : Quantity of non dairy additives

Due to moisture contents of non dairy additives namely stevioside and CMC were practically negligible, it could be considered that:

$$ANDAS \simeq NDAQ$$

Likewise, the little fat contents of liquid skimmed milk and DWPC were disregarded.

Thereafter, all WGC blends were homogenized using X520, UAC 30-R, Chicago II G064 (3000 rpm/min.) homogenizer at 55-60°C and further heat treated to 74°C for 30 sec. followed by rapidly cooling to 5±1°C at which they were held 24 h. for aging.

3. Whipping process

The aged WGC blends were whipped at 5±1°C using superhand mixture (National, Japan) at the maximum speed. Whipping times were recorded in sec. Three replicates were carried out for every treatment.

Analytical methods

Dry matter, fat, total nitrogen, ash and titratable acidity contents were determined as in AOAC (2000). pH value was

measured using pH meter model Cole-Armer Instrument Co., USA. Rheological parameters were measured using a Coaxial rotational viscometer (Rheotest II, Medingen, Germany) at 10±1°C at shear rates ranged from 3 to 1312 sec.$^{-1}$. Consistency coefficient and yield stress were calculated from the ascending flow curve as described **Toledo (1980) and Bourne (1982),** respectively. The whippability expressed as whipping power (overrun %) was measured according to **Anderson *et al* (1983).** While, the whippstability was expressed as leakage % and slipping % as described by **Fayed *et al* (1991).** Whereas, volume of the syrup or the serum released from the motionless whipped cream along 24 h at frig. temperature. The leakage was monitored and expressed as percentage of initial whipped cream volume. The slipping percent, which is the reduction in the total volume of whipped cream along 24 h at frig. temperature was also followed up and calculated. Caloric value was calorimetrically determined using Ballistic Bomb Calorimetric, Gallenkamp according to the method described by **Walstra and Jenness (1984).** Whilst, the theoretic caloric value was calculated using figures of **Renner and Renz-Schauen (1986).** Samples were organoleptically evaluated according to the scheme of **Bodyfelt *et al* (1988).** The obtained data were statistically analyzed according to **SPSS (1998).**

RESULTS AND DISCUSSION

1. Chemical properties of whipping cream blends

The results given in **Table (2)** show that, the figures of TS and fat contents are surrounding the previously adjusted levels as experimentally designed. The protein content of WGC was proportionally raised as the fat content reduced, especially when Simplesse was used as fat mimetic *vis a vis* Slendid ($P<0.01$). That could be, indeed, due to the Simplesse which is a whey-protein origin agent while, Slendid is a pectin ester. The ash content exhibited also significant increases ($P<0.01$) associated with the reduction in the fat content of WGC because of the bulking agent (DWPC), which contains about 12% ash. Similar observations were found in light calorie sour cream by **Fayed *et al* (2006).** The increased ash level has relatively multiplied in the case of Slendid containing WGC compared with that containing Simplesse ($P<0.01$). That could be attributed to the Slendid, that is a calcium binding agent **(Copenhagen Pectin A/S Co 1994)** rather than Simplesse. Moreover, the DWPC used contained also about 14% lactose, therefore, the obtained WGC was loaded with an increased carbohydrate level ($P<0.01$) as the fat content reduced. Further, the carbohydrate based fat mimetic, namely Slendid, caused an additional increase in the carbohydrate level of WGC ($P<0.01$) as seen in **Table (2).**

The acidic influence of Simplesse was higher than that of Slendid leading the resultant WGC to appear an acidity % slightly higher and hence lower pH value as the fat content was replaced with it ($P<0.05$).

The replacement of WGC with a mixture of Slendid and Simplesse (1:1) imparted middle values *vis a vis* Slendid or Simplesse alone **(Table, 2).**

Table 2. Chemical properties and energy load of whipping cream blends as affected by the level and kind of fat mimetic

Properly	Designed fat level						
	35%	25%			15%		
	(control)	SL	SP	Mix	SL	SP	Mix
Total solids%	41.02	40.95	41.20	41.02	40.85	40.87	41.10
Fat %	35.3	25.2	25.6	25.4	15.4	15.7	15.5
Total protein% (N x 6.38)	2.44	6.78	9.48	8.13	13.23	16.81	15.02
Ash %	0.54	1.69	0.72	1.21	2.81	0.89	1.85
Carbohydrate %*	2.74	7.28	5.40	6.28	9.41	7.47	8.73
Acidity %**	0.17	0.18	0.20	0.19	0.19	0.23	0.21
pH value	6.69	6.65	5.65	6.05	6.60	5.30	6.00
C. caloric value (K. cal/ 100 g)	719.0	600.7	604.2	602.5	471.6	490.2	480.9
T. caloric value (K. cal./100 g)	349.5	292.0	299.1	299.5	236.0	245.6	240.8

* Calculated by the difference ** As lactic acid
C. Calorimetric SL : Slendid SP : Simplesse Mix: SL : SP (1:1)
T. : Theoretic

2. Energy load of whipping cream blends

Data of Table (2) reveal also that, caloric values of WGC, whether those calorimetrically determined or theoretically calculated, decreased significantly as the fat content lowered regardless the kind of the fat mimetic used. At a given level of fat replacer, Simplesse caused the WGC to be characterized with slightly higher caloric value, because it is possessing 1⅓ Kcal/g while, Slendid is caloric free (**Benz, 1992 and Kammerlehner, 1993 and Copenhagen Pectin A/S Co 1994**). Moreover, it could be noticed that, the caloric values obtained using *in vitro* method were always about two times higher than those obtained theoretically. These phenomena agree with those observed by **Fayed *et al* (2006)**. However, the corresponding values ranked the second order at any certain replacement level of fat, when the mixture of Slendid and Simplesse was used.

3. Rheological profile of whipping cream blends

As seen in Table (3), the rheological measurements of WGC exhibited different responses among the level and kind of the fat mimetic.

Table 3. Physical properties and rheological profile of whipping cream blends aged for 24 h. at 5±1°C as affected by the level and kind of fat mimetic

Properly	Designed fat level						
	35%	25%			15%		
	(control)	SL	SP	Mix	SL	SP	Mix
Consistency coefficient (dyne.sec/cm^2)	15.76	26.41	19.96	24.15	36.58	23.71	30.00
Yield stress (dyne/ cm^2)	104.47	569.18	147.79	458.30	819.55	243.93	631.82
Whipping times (sec.)	100	85.0	125.0	100.0	70.0	150.0	100.0
Overrun %	60.7	37.8	57.3	56.6	30.3	55.8	54.5
Leakage %	ND	ND	ND	ND	ND	ND	ND
Slipping %	ND	ND	ND	ND	ND	ND	ND

SL : Slendid SP : Simplesse Mix: SL : SP (1:1) ND : Not detected

As beginning, the proportional protein enrichment by adding DWPC, with its considerable water holding capacity, as a bulking agent at the expanse of the fat content of WGC resulted in variable increases in its both consistency coefficient and yield stress. Presence of Slendid led to heighten the consistency coefficient and to jump highly the yield stress. That means, it required more shear stress to begin flow. **Prentice (1992)** reviewed that, if measurements are made on a thick cream using rotation viscometer an "overshoot" phenomenon becomes very evident. That obviously indicates the Slendid to promote the thin cream to exhibit flow behaviour like to thick cream. **Copenhagen Pectin A/S Co (1995)** pronounced that, Slendid has a high water holding binding capacity (50 times its own weight) and is shear resistant .While Simplesse caused gradual increases in the consistency coefficient associated with proportional increases in the yield stress of WGC along fat replacing. The trends of this results are in coincidence with those reported by **Fayed *et al* (2006).** The increase rate due to Slendid was more pronounced *vis a vis* Simplesse ($p<0.01$). Whilst, the mixture of both fat mimetics led to improve the flow behaviour gained by the latter **(Table, 3).**

4. Whippability of cream blends

Whippability parameters, those including the whipping time required to reach the maximum overrun, whipping power (overrun %), the leakage and slipping percentages of whipped cream, displayed variable responses as present in **Table (3).** Although the whipping time accelerated by Slendid, the whipping power was harmed and the cream persistence to be whipped was reduced. That means, the cream tended to destabilized at exceeded whipping as the butter churning process sets in. **Prentice (1992)** ex-

plained that, the excessive whipping led to reduce the air bubbles size and the interstitial spaces between them became too small for the maintenance of a strong mesh and the foam began to collapse again. On the contrary, the fat reduction, *via* its replacement with Simplesse, led to prolong the whipping time, although the gained overrun% was comparable. Similarly, the backward relationship between the fat content and whipping time was observed by **Towler, (1982); Scurlock, (1987); Ghita *et al* (1992) and Abd El-Salam *et al* (1993).** Moreover, **O'Mullane and Foley (1970)** attributed also the prolongation of whipping time of low fat content cream to the increase in the protein content by adding UF retentate. The whipping time did not outreach that of the control when the mixture of Slendid and Simplesse was used as fat mimetic of WGC, though the overrun% was slightly lower than that gained by Simplesse alone. Data indicated also that, neither the fat content nor the kind of fat mimetic resulted in any significant effect on the of whippstability as explained by monitoring the leakage which reflecting the phase stability of whipped cream against syrup liberation and the slipping which reflecting the entrapping stability of air bubbles in the system. Where neither serum release nor volume reduction was observed in the motionless whipped cream along the experimental period (24 h) at 5±1°C.These observations were in coincidence with those reported by **Hiddink *et al* (1986); Brooker *et al* (1986); Anderson *et al* (1987); Fayed *et al* (1991) and Salem and Zeidan (1993).**

5. Organoleptic quality of whipped cream

The organoleptic quality of whipped cream was significantly declined when the fat content was lowered, particularly when more than 25% and/or the Slendid was used as fat replacer. The most inferior samples of 15% fat had 83% of the total sensory scores of the control, **(Table, 4).**

Table 4. Organoleptic scores of whipping cream as affected by the level and kind of fat mimetic

Properly	Designed fat level						
	35%	25%			15%		
	(control)	SL	SP	Mix	SL	SP	Mix
Appearance (25)	25	22	23	24	20	22	23
Consistency (25)	25	21	24	25	18	22	23
Flavour (50)	50	47	50	49	45	48	47
Total (100)	100	90	97	98	83	92	93

SL : Slendid SP : Simplesse Mix: SL : SP (1:1)

In details, the yellowness colour was the most pronounced appearance-view when Slendid was used in 15% fat whipped cream. However, all samples were characterized with considerable stability. Moreover, Slendid-containing whipped creams were sensory characterized with a firm body, besides, slight after-taste was detected. The use of the mixture of both fat mimetics studied led to improve all organoleptic criteria, resulting in a whipped cream able to gain 93% of the total quality of the control (35% fat) in spite of its low fat content (15%).

Generally, the foregoing results could lead to conclude that, it is successfully possible to produce light calorie whipped cream with comparative whipping attributes and good sensory quality using a mixture (1:1) of Slendid and Simplesse for replacement of about 50% of the original fat content and Stevioside as diet sweetener (0.01%).

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إنتاج قشدة مخفوقة منخفضة السعرات بإستخدام دهون مقلدة واستفيوسيد

[٨]

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استهدف البحث إنتاج قشدة مخفوقة منخفضة السعرات ودراسة علاقة ذلك بالخواص الكيماوية والطبيعية والريولوجية والحسية. ولتحقيق ذلك تم إنتاج مخلوط قشدة خفق أساسي يحتوى علي ٤١% جوامد كلية، ٣٥% دهن و٠,٠١% أستفيوسيد Stevioside و٠,٣% صوديوم كربوكسى ميثيل سليلوز. وذلك بإستخدام قشدة طازجة (٥٠% دهن) ولبن فرز (٩% جوامد كلية). ولإنتاج قشدة خفق منخفضة الطاقة تم خفض الدهن إلى ٢٥% و١٥% إعتمادا علي إستخدام Simplesse، Slendid أو خليط منهما بنسبة ١:١ كبدائل مقلدة للدهن علي أساس أن ٠,١% بديل دهنى يحل محل ١% دهن، كما تم إستخدام بروتينات شرش مركزة مجففة (٩٥% جوامد كلية) لتعويض النقص الحادث في محتوى القشدة من الجوامد الكلية نتيجة لخفض المحتوى الدهنى ليظل دائما ٤١% جوامد كلية إسوة بالكنترول.وقد تم تجنيس جميع المعاملات وذلك علي درجة حرارة ٥٥ - ٦٠°م ثم تم إجراء معاملة حرارية علي ٧٤°م/ ٣٠ث ثم التعتيق لمدة ٢٤ ساعة علي ٥±١°م والتى عليها تم إجراء عملية الخفق باستعمال المضرب الكهربائى علي السرعة القصوى.

أوضحت النتائج حدوث زيادة في محتوى القشدة من البروتين والكربوهيدرات والرماد والحموضة مع استبدال الدهن بينما حدث انخفاض في كل من قيم الpH والقيمة السعرية.كما حدث زيادة تدريجية في كل من معامل القوام كنتيجة لإستخدام بدائل الدهن المقلدة وخاصة الـ Slendid والذى رفع بشدة من جهد القص الأبتدائى بالمقارنة بSimplesse. وطال وقت الخفق بإستخدام Simplesse وقصر بإستخدام Slendid ولم يتغير بإستخدام خليط منهما. ولقد انخفض الريع بدرجة كبيرة عند استخدام Slendid وبدرجة أقل عند استخدام Simplesse أو خليط منهما ولم يلاحظ أى إنفصال للمصل أوهبوط فى حجم القشدة المخفوقة الساكنة لمدة ٢٤ساعة علي ٥±١°م.

ولقد أظهر الفحص الحسى أن إستخدام خليط من Slendid وSimplesse في القشدة المخفوقة ٢٥% دهن أدى إلـــي إعطـــاء درجات تحكـــيم بلغـــت ٩٨% بالنســـبة للكنترول ويليها المحتوية علي Simplesse فقط (٩٧% بالنســـبة للكنتـــرول) بينمـــا المحتوية علي ١٥% دهن حصـــلت ٩٣و ٩٢% علي التوالى.

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