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Utilization of Ras Cheese Salt Whey in the Manufacture of Fatty Dairy Products

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ABSTRACT

Ras cheese whey is a by–product produced during cheese making. It has healthy nutritional contents that are nearly equal to half of the nutritional value of milk. However, it is completely wasted.The objective of this study is to utilize Ras cheese salt whey (W) in manufacturing cream (WC), butter (WB), and ghee (WG). The prepared products were analyzed and compared with those made from cow´s milk [milk cream,(MC), milk butter (MB) and milk ghee (MG),]. The attained results revealed that the yield of WB was significantly higher (82.12%) than in MB (65.84%), and almost the same in WG, and MG. The WC had lower values, protein, and lactose but contained higher acidity total solids, fat and ash than MC. Insignificant differences were observed in total solids, and fat contents in WB compared to MB, while acidity and ash in WB were higher compared to MB. Profiles of fatty acids (FA) were different in the prepared ghee since WG was richer in short and medium–chain FA than MG, while the opposite was recorded concerning long-chain FA. The prepared WG was characterized by much higher values for saponification No., acid value, Reichert, and Polenske values while slightly lower values for ester and thiobarbituric acid (TBA) than MG. The total sensory properties of WG and MG were very close and did not differ in the case of WG and MG. Counts of total bacteria, yeast, and moulds were higher in cream, and butter prepared from whey than those prepared from milk.

Keywords: Whey, Cream, Butter, Ghee, Fatty acids.

INTRODUCTION

Fatty dairy products (cream, butter, and ghee) are high in fat components that are good for health, high in cholesterol, saturated and unsaturated fatty acids, and triacylglycerol (Jensen, 2002). The cream is a part of milk rich in fat; it is prepared by applying centrifugation at the whole milk based on the difference in the specific gravity of fat and skim milk. It consists of water (60%), lipids (37%), proteins (2.1%), carbohydrates (2.8%), and ash (0.5%) (Karaca *et al*., 2018). Butter is a water-in-oil emulsion; it is made usually by churning fermented cream to separate the buttermilk from the butterfat. It has a minimum fat content of 80%, a water content limit of 16%, and often 3% non-fat milk solids (0.9% protein, 0.1% carbohydrates, and 2.1% fat) (Mortensen *et al*., 2011). Ghee is prepared by boiling butter or cream at 110 to 120ºC to remove moisture. It has a minimum of 99.6% milk fat, 0.4% free fatty acids, and a maximum of 0.1% moisture (Codex, 2003).

Cheese whey is a dairy by-product since every kg of cheese produces around 9–10 L of whey (Tsermoula *et al*., 2021). The production amount of cheese whey has increased as a result of the dairy industry's rapid growth (Elleuch *et al*., 2020). In just about the past 45 years, the worldwide production of whey has increased by over 100% and reached 160 million tons in 2020. According to the global cheese market, the worldwide production of cheese in 2023 is estimated to be 26 million tons, leading to 230 million tons of cheese whey (Rama *et al*., 2019; Choi *et al*., 2020). More than half of this whey is wasted, used as animal feed, biofertilizer in irrigation systems, or dumped directly into the environment (Kotoulas *et al*., 2019; Ostertag *et al*., 2021). The physicochemical properties of whey are influenced by many variables, such as the type of cheese produced, the milk's composition, the animal's food, the animal's lactation stage, and management (Trindade *et al*., 2019). Generally, cheese whey is composed of 90% water, 4-5% lactose, 0.6-0.8% soluble proteins, 0.4-0.5% lipids, and 0.5-0.7% minerals (Guo and Wang, 2019).

Cheese whey has a high biological oxygen demand (BOD) and chemical oxygen demand (COD). This poses a serious risk to aquatic life, the environment, and public health when dumped into water sources because it decreases the amount of dissolved oxygen in the water (González-Siso, 1996). About half of the amount produced is processed and used in animal or human meals; the remainder is either sent for effluent treatment, which incurs additional costs, or originated from improper sewage disposal, causing water or soil contamination and environmental hazards (Macwan *et al*, 2016; Izzo, *et al*., 2020). Due to its high nutritional value and daily production, cheese whey is of great interest to the industry and has the potential to be used as a food ingredient (Rama *et al*., 2019). Sweet whey is utilized as a component in the preparation of flour, meat products, drinks, and infant food. Fruit beverages, fermented milk, and salad seasonings are all made with acid whey [Smithers, 2015; Panghal *et al*., 2018; Faucher *et al*, 2020). In addition, the separation of whey fat using centrifugation and the possibility of using it in making some dairy products were done by Bohdziewicz (2006) and Jinjarak *et al.* (2006).

In Egypt, Ras cheese is the most popular hard cheese similar to the Greek type (Kefalotyri), and its popularity is mainly due to its unique taste and aroma. Ras cheese is usually made in most Egyptian areas and small factories from raw

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milk to get the best flavour of cheese since no specific starter culture is available for such cheese. Some trials were achieved to improve the hygienic quality of the resultant cheese by using pasteurized milk (Mehanna *et al*., 2008; Mehanna *et al*., 2018). In all cases, Ras cheese salt whey is characterized by its high salt content and richness with valuable milk components such as protein, fat, lactose, whey proteins, minerals, and lactic acid. Such whey, unlike sweet whey, cannot be conveniently processed because of its high salt level (Sanderson *et al.*, 1994).

Ras cheese sweet whey was used in some studies to prepare whey cream (El-Ghandour, 2015) and whey butter (Aly, 2009). Why cream (WC) and whey butter (WB) are characterized by a high concentration of unsaturated fatty acids as well as biologically active substances (including sphingomyelin and mucins) compared to those made from milk (Parodi, 1999; Jinjarak *et al.*, 2006; Aly, 2009 and Nadeem *et al*., 2015). Aly (2009) reported that WB has higher linolenic fatty acid content than MB, which gives it superior nutritional quality and healthiness. Additionally, other researchers showed no appreciable variations between the physicochemical composition of WB and MB [Aly, 2009; Nadeem *et al*., 2015; Morin *et al*., 2006].

On the other hand, Ras cheese salt whey was used in processed cheese making (Ayad *et al*., 2011; Awad *et al*., 2013)] and the production of clotting enzymes (El-Tanboly *et al*., 2013). However, salt whey is not recycled in any significant industrial process so far in Egypt. This study aimed to use Ras cheese salt whey to produce fatty dairy products (cream, butter, and ghee) and evaluate the properties and the acceptability of these products comparable to those made from milk**.**

MATERIALS AND METHODS

Materials:

Fresh cow´s milk (C) (4.2% Fat, 3.2% protein, and 0.7% ash) was obtained from the dairy science department, Faculty of Agriculture, Kafrelsheikh University, Egypt. Ras cheese whey (W) with the composition of 0.8% fat, 0.8% protein, 4.2% salt, and 0.4% ash were collected from El-Essay dairy factory (Fuwwah city, Kafer El-Sheikh governorate, Egypt). DVS mesophilic culture (consisting of *Lactococcus lactis*, *Lactococcus cremoris*, *Leuconostoc cremoris*, and *L. lactis diacetylactis*) was obtained from Chr. Hansen, Copenhagen, Denmark.

Manufacture of cream, butter, and ghee:

The milk cream (MC) and whey cream (WC) were prepared by conventional centrifugal separation. The prepared MC and WC were inoculated with 0.07% of the mesophilic culture until pH 5.0±0.02 then churned to butter (MB and WB) using the method described by Jinjarak *et al*. (2006). Ghee was prepared from MB and WB by the traditional boiling procedure.

Analysis Methods:

The yield of cream, butter, and ghee.

The yield of the resultant cream from milk or whey was calculated according to the following equation:

The Yield of cream [%] = [weight of cream/ weight of milk or whey] *100.

The yield equation of butter was as the following:

The Yield of butter [%] = [weight of butter/ weight of the used cream] *100.

While in the case of ghee the yield was calculated as the following:

The Yield of ghee [%] = [weight of ghee/ weight of the used butter] *100.

Chemical analysis of cream and butter:

Acidity percentage (as lactic acid) was determined as the method described by Caric *et al*. (2002). Total solids were achieved using direct oven drying in a forced air oven at 102 ^{O}C for 3h, while the ash content was obtained by burning the samples at 550 ^{O}C in a muffle furnace (Marshall, 1992). Using the macro-Kjeldahl method, the protein was produced with a nitrogen-to-protein conversion factor of 6.38 (Marshall, 1992). The Mojonnier ether extraction method was used to measure fat content (Marshall, 1992). According to the procedure outlined by AOAC (2016), lactose was quantified as follows: 250 ml of distilled water and 6 drops of phenol (80%) were combined with 0.25 ml of the sample. After then, 2 ml of the previous solution was mixed with 5 ml of sulfuric acid (with blowing), and the mixture was then kept for about 10 minutes at room temperature. A colourimeter set at 490 nm was used to measure the colour's concentration.

Fatty acids composition and fat constants of ghee:

Fatty acids profiles of MG and WG were measured according to AOAO (2016). The gas chromatographic analysis was carried out using ACME model 6100 GC (Young LIN Instrument Co., Korea) fitted with a split injector and FID detector. Nitrogen was used as carrier gas with a flow rate of 0.8 ml/min. The components were separated on a 30 m SP – 2380 fused-silica capillary column with 0.25 mm i.d. and 0.2 µm film thickness (Supelco, Bellefonte, PA) and the detector temperature was set at 260 °C. The injector temperature was set at 220 °C in split mode (split ratio 1:80). The column was initially maintained at 140 °C for 5 min, and the temperature was subsequently increased to 240 °C at the rate of 4 °C /min.

All ghee samples were tested for saponification number (SN), acid value (AV), ester value (EV), peroxide value (PV), Reichert (Re) and Polenske (Po) values as described in AOAC (2016). Thiobarbituric acid (TBA) and hydroxymethyl furfural (Free and Potential HMF) were also measured according to the procedures given by Pokorny *et al.* (1985) and AOAC (20016) respectively.

Microbiological analysis of cream, butter, and ghee:

Microbiological analysis including total bacteria counts (TBC), yeasts and moulds (Y and M) as well as, coliform bacteria was done according to Frank *et al.* (1992).

Sensory evaluation of cream, butter, and ghee:

The sensory properties of fatty dairy products were evaluated by ten professional panelists from Kafrelsheikh University, Faculty of Agriculture. The cream samples were assessed in the light of the information mentioned by Nelson and Trout (1981) taking into consideration the acidity and saltiness of whey used in making WC. The method described by Bodyfelt *et al.* (1988) was used to evaluate the sensory properties of butter, while the method of Pena-serna *et al.* (2020) was used to estimate the sensory of ghee.

Statistical analysis:

The SPSS version 10.0 programme was used to conduct the statistical analysis. Analysis of variance and Duncan's test at the significance level of $p = 0.05$ were used to measure the significant differences between means. Three replicates of the data were used to calculate the mean and standard error (SE) (SPSS, 2016).

RESULTS AND DISCUSSION

The yield of cream, butter, and ghee:

Although the yield of milk cream (MC) was dramatically higher compared to cream prepared from whey (WC), the yield of butter from whey (BW) was significantly higher compared to that obtained from milk (BM) (Table 1). The presence of high salt in CW could be an affecting factor in this respect. On the other hand, the yield of milk ghee (MG) was similar to whey ghee (WG).

Table 1. The yield (%) of cream, butter and ghee prepared from milk and Ras cheese whey

Raw materials	Yield (%)		
	Cream	Butter	Ghee
Milk	78.18±0.93^{a}	65.84±0.93^{b}	77.10±0.02^{a}
Whey	1.04±1.41^{b}	82.12±1.41^{a}	77.34±0.14^{a}

- Data are mean ± SE for three replicates
- Means with different superscripts differed significantly (P ≤ 0.05)

Chemical analysis of cream:

The acidity and gross chemical composition of cream prepared from milk (MC) and whey (WC) are shown in Table (2) The WC was characterized by higher significant ($P \leq 0.05$) values for acidity, TS, fat, and ash while significantly lower values for protein and lactose. The present results agree with those given by El-Ghandour (2015) who reported that WC had significantly higher values of acidity, TS, fat and ash whereas the protein content was significantly lower compared to MC. Brighenti *et al.* (2021) reported that the TS and fat contents in WC were significantly higher however protein was significantly lower compared to MC. In addition, the data given by Morin *et al.* (2006) confirmed that WC contained higher TS and lower protein content compared to MC. The fermentation of lactose during Ras cheese making may be responsible for the high acidity and the low lactose content of the prepared cream from whey.

Table 2. Acidity (%) and gross chemical composition (%) of cream prepared from milk (MC) and from Ras cheese whey (WC).

Cream	Acidity	TS	Fat	Protein	Lactose	Ash
MC	1.25±0.17^{b}	65.94±0.16^{b}	52.44±0.24^{b}	1.49±0.01^{a}	12.32±0.01^{a}	0.11±0.00^{b}
WC	2.60±0.16^{a}	72.46±0.28^{a}	66.77±0.22^{a}	0.67±0.00^{b}	3.67±0.01^{b}	1.5±0.011^{a}

- Data are mean ± SE for three replicates
- Means with different superscripts differed significantly (P ≤ 0.05)

Chemical analysis of butter (B):

Table (3) shows insignificant differences ($P > 0.05$) in TS and fat content between MB and WB. On the other hand, acidity value and ash content were significantly higher ($P \leq 0.05$) in WB compared to MB. The attained results agreed with the data given by Aly (2009) who used Ras cheese whey in the making WB and gave the values (%) of 83.85 and 80.08 for the TS and fat contents of WB, whereas the corresponding contents of MB were 83.38 and 79.4 in order. According to Morin *et al.* (2006) MB and WB had the exact contents of TS and fat. In general, many researchers confirmed no remarkable differences between MB and WB in their physicochemical properties (Jinjarak *et al*., 2006 and Nadeem, *et al*, 2015).

Table 3. Acidity (%) and chemical composition (%) of butter prepared from milk cream (MB) and from whey cream (WB).

Butter	Acidity	TS	Fat	Ash
MB	0.50±0.00^{b}	80.92±0.02^{a}	79.22±0.32^{a}	0.52±0.00^{b}
WB	2.00±0.00^{a}	81.17±0.14^{a}	80.33±0.66^{a}	1.23±0.08^{a}

- Data are mean ± SE for three replicates
- Means with different superscripts differed significantly (P ≤ 0.05)

It may be of benefit to reveal that a valuable by-product (buttermilk) was collected when butter was prepared from whey. Analysis of the collected buttermilk revealed it contained much higher TS (13.97%) and ash (5.45%), while lower fat (1.48%) than those of buttermilk collected during making butter from milk since the corresponding values were 7.66%, 0.8%, and 2.22% in order (not tabulated data). More details were about the composition, quality, and importance of buttermilk were recently given by Hebatalla *et al.* (2018) and Mehanna *et al*. (2020).

Fatty acids composition and fat constants of ghee:

As shown in Table (4), fatty acids can be classified according to their length to short-chain (SCFA), medium-chain (MCFA), and long-chain fatty acids (LCFA). The SCFA (C4-8) content was much higher (3.52%) in WG (prepared from whey) than in ghee prepared from milk (MG) since the corresponding content was as a percentage of the total only 1.59%. This was also true concerning MCFA (C10-14) since their percentages were 22.94 and 21.23 for whey ghee (WG) and milk ghee (MG), suggesting richness of WG with short and medium-chain fatty acids. The opposite was observed concerning LCFA (C15-18) since the recorded values for WG and MG were 71.06% and 76.94%. However, in both cases, fatty acids composition showed on the order of LCFA > MCFA > SCFA. It is clear to notice that WG are almost free of all unsaturated fatty acids except oleic acid (C18 1n9c), presented in a significantly higher percentage in WG (20.81) compared to MG (14.86). By the way, the content of the total saturated fatty acids in MG is much higher compared to the unsaturated fatty acid. The differences in fatty acids composition of butter samples prepared from milk or whey were the main reason for the recorded differences in the fatty acids profile of the prepared ghee samples. Expect a softer, smoother body and texture, as well as greater spreadability and a lower melting point of the fatty product due to the higher level of SCFA and unsaturated fatty acids (Shi, *et al*. 2001; Aly, 2009). On this point, Aly (2009) mentioned that WB had a higher content of SCFA and total unsaturated fatty acids than MB. The prementioned MB was prepared from cow´s milk, whereas Ras cheese whey was used for making WB. Data of MG agree –in general – with many previous types of research (Abd El-Aziz, 2008; Kumar *et al*., 2018; Zommara *et al*., 2018) which reported that MG had much higher LCFA followed by MCFA than SCFA. In addition, the concentration of saturated fatty acids in MC was significantly higher compared to unsaturated fatty acids (Hae-Soo *et al*., 2013; Zommara *et al*., 2018). On the other hand, no data are available from the works of literature for making a comparison between MG with WG.

Such differences in fatty acids profile due to the various sources of the prepared ghee greatly affected the fat contents of the products. Table 5 reveals that the fat content in WG did not differ ($P > 0.05$) with MG. The saponification number (SN) and acid value (AV) were higher ($P \leq 0.05$) in ghee prepared from whey (WG) than those of MG. Such as values accompanied by more SCFA given for WG as shown in Table 4. Whereas MG contained so much higher ester value (EV) (22077) compared to WG (649). The same correlation was previously mentioned by Zommara *et al.* (2018).

In the present study, the oxidation of fat was followed up by measuring peroxide value (PV) and thiobarbituric acid value (TBA). Both values were slightly lower in WG than in MG (Table 5). However, the period needed, and conditions of such oxidation should be considered. Gray (1978) mentioned that there was a transformation of peroxides and hydroperoxides into some aldehydes, ketones and other compounds negative to peroxide reaction. On the other hand, the volatile fatty acids (VFA) in the prepared ghee samples expressed as Reichert value and Polenske value were much higher in WG compared to MG and were accompanied by a higher content of SCFA (Table 4). However, the prementioned values represent soluble and insoluble VFA (Davis, 1953).

Table (5) reveals WG was characterized by a much higher value in free hydroxymethyl furfural (HMF) than MG. such value was accompanied by a higher value for potential HMF. The use of annatto as a colouring agent for Ras cheese besides the processing could be the reason for such an increase in free and potential HMF.

Table 4. Proportions of fatty acids (% of the total) in ghee prepared from milk (MG) and from Ras cheese whey (WG).

Fatty acid	MG	WG
C8	1.59±0.03^{b}	3.52±0.23^{a}
C10	3.17±0.50^{b}	5.67±1.15^{a}
C12	3.44±0.80^{b}	4.24±0.03^{a}
C14	12.71±1.56^{a}	13.03±0.65^{a}
C14 1n9c	1.91±0.01^{a}	--------
C15	2.05±0.15^{a}	1.51±0.06^{b}
C16	38.65±3.02^{a}	30.84±2.15^{b}
C16 1n9c	1.43±0.00^{a}	----------
C17	1.22±0.03^{a}	----------
C18	15.50±1.23^{b}	17.19±0.86^{a}
C18 1n9t	1.93±0.43^{a}	0.71±0.00^{b}
C18 1n9c	14.86±2.27^{b}	20.81±1.58^{a}
C18 2n6c	0.69±0.00^{a}	--------
C18 3n3	0.61±0.01^{a}	--------
SCFA (C4-8)	1.59±0.10^{b}	3.52±0.03^{a}
MCFA (C10-14)	21.23±0.53^{b}	22.94±1.00^{a}
LCFA (C15-18)	76.94±3.15^{a}	71.06±2.75^{b}

- Data are mean ± SE for three replicates
- Means with different superscripts differed significantly ($P \leq 0.05$)

Table 5. Fat constants of ghee prepared from milk (MG) and from Ras cheese whey (WG).

Property	MG	WG
Fat (%)	99.85±0.82^{a}	99.82±0.54^{a}
Saponification number (SN) (mg KOH/g)	221.77±0.70^{b}	640±2.88^{a}
Acid value (AV) (mg NaOH/g)	0.99±0.07^{b}	1.53±0.03^{a}
Ester value (EV)	22077±0.16^{a}	649±3.53^{b}
Peroxide value (PV)	0.80±0.16^{a}	0.73±0.16^{a}
Thiobarbituric acid (TBA)	0.34±0.00^{a}	0.26±0.00^{b}
Reichert value	25.88±0.35^{b}	30.44±0.55^{a}
Polenske value	2.62±0.05^{b}	3.36±0.04^{a}
Free HMF	0.62±0.01^{b}	1.81±0.01^{a}
Potential HMF	2.50±0.01^{a}	2.56±0.09^{a}

- Data are mean ± SE for three replicates
- Means with different superscripts differed significantly ($P \leq 0.05$)

Our results of the ghee constants were found to be within the parameters of Egyptian standards (ES: 154-8/2005). It may be interested to point out the results given in the literature in this respect for milk ghee prepared by boiling. Khalifa and Mansour (1988) gave values of 0.40, 0.0 and 0.105 for AV, PV and TBA in order, whereas Metwally *et al.* (2001) gave values of 0.4 and 0.53 for AV and PV in order. Zommara *et al.* (2018) analyzed anhydrous milk fat (Ghee) and gave values of 227.4 for SN, 0.12 for AV, 0.8 for PV, and values of 29.6 and 1.17 for Reichert and Polenske respectively. The values of SN and AV in cow ghee were 217 (mg KOH/g) and 0.12 (mg NaOH/g) in order (Bodyfelt, *et al.*, 1988).

Microbiological analysis of cream, butter, and ghee:

The quality of all the prepared products was tested by carrying out microbiological analysis including total bacterial count (TBC) and counts of yeasts and moulds (Y & M) as well as coliform. In comparison, Table (6) reveals that the numeration of bacteria as log CFU/g was higher (4.61) in the case of WC than 4.06 in MC. This also was recorded for butter samples with counts (log CFU/g) of 8.42 and 8.08 for WB and MB in order. The same trend of results was observed concerning Y & M since their counts were always higher in the products made from whey (WC and WB) than those made from milk (MC and MB), while the boiling process done in making ghee was able to kill all the bacteria as well as Y & M present in cream and butter. All the prepared ghee samples were free of bacteria and Y & M, at the same time all the prepared fatty dairy products were free of coliform suggesting good hygiene with no contamination during processing. The total count of milk cream agreed with Jay (2000), who reported that its count was 4.30 CFU/ml. Johnson *et al.* (1997) illustrated that TBC and Y&M in WC were significantly higher compared to the counts in MC, this may be related to the low hygienic conditions during cheese production and whey handling before pasteurization.

Table 6. Microbiological quality (Log CFU/g) of cream (MC) butter (MB) and ghee (MG) prepared from milk and from Ras cheese whey expressed as WC, WB and WG in order.

Product	Total bacteria count	Yeast & Moulds	Coliform
MC	4.06±0.13^{b}	3.90±0.05^{b}	ND
WC	4.61±0.03^{a}	4.80±0.02^{a}	ND
MB	8.08±0.14^{b}	4.54±0.03^{b}	ND
WB	8.42±0.03^{a}	4.93±0.02^{a}	ND
MG	ND	ND	ND
WG	ND	ND	ND

- Data are mean ± SE for three replicates
- Means with different superscripts differed significantly ($p \leq 0.05$)
- ND: Not detected

Sensory properties of cream, butter, and ghee:

The scores given for appearance, body & texture and flavour of WC were lower ($P \leq 0.05$) than those of MC, but the total score of WC was higher than 65 out of 100 points suggesting the prepared WC was acceptable in general (Table 7). Johnson *et al.* (1997) reported that the WC was characterized by lower flavour and quality than MC. The undesirable flavour of WC may be attributed to the high acidity produced by starter bacteria during cheese manufacture as well as the high salt content of the used whey.

The data tabulated in Table (8) show insignificant differences between the butter made from milk and whey in flavour and body & texture attributes. The whey butter (WB) recorded significantly lower scores of colour, appearance and salts than milk butter (MB). The unfavourable colour of WC and WB may be related to adding Annatto colouring agent to milk cheese during the processing of Ras cheese which transferred to the resultant whey used in the manufacture of WC and WB. On the other hand, the used whey in the manufacture of WC and WB was salted (4.2%). However, the milk cream used in making MB was unsalted, so the salty taste of whey products was significantly lower than those made from milk. Although the total score of sensory properties of WB was significantly lower than MB, it was very acceptable to the panelists. The differences in the sensory properties between MB and WB were also obtained by Aly (2009), who confirmed the major difference between WB and MB is that WB had a strong yellow colour than MB (glossy light-yellow) which was unacceptable as the colour of MB. WB has a softer texture than MB due to a higher percentage of unsaturated fatty acids in whey cream. According to Jinjarak *et al*. (2006), WB was more yellow than MB, while the texture of MB was generally harder than WB.

The comparison between MG and WG in the sensory evaluation was shown in Table 9. MG recorded significantly higher scores for appearance and texture. Contrarily, the odour and flavour of WG were higher compared to MG. It was interesting to observe, the total score given for MG was remarkably close to that given to WG. Aly (2009) reported that whey butter with a high flavour rating is more suited for preparing or cooking Samna (ghee).

Table 7. The sensory properties of cream prepared from milk (MC) and from Ras cheese whey (WC).

Cream	Appearance (10)	Body & Texture (30)	Flavour(60)		Total (100)
			Acidity (30)	Saltiness (30)	
MC	8.88±0.26^{a}	28.77±0.33^{a}	28.33±0.37^{a}	29.22±0.27^{a}	95.20±0.14^{a}
WC	6.00±0.25^{b}	20.33±1.14^{b}	22.55±0.8^{b}	18.66±0.84^{b}	67.54±0.09^{b}

- Data are mean ± SE for three replicates
- Means with different superscripts differed significantly ($P \leq 0.05$)

Table 8. The sensory properties of butter prepared from milk (MC) and from Ras cheese whey (WC).

Butter	Flavour (10)	Body & Texture (5)	Colour & Appearance (5)	Salt (3)	Total (23)
MB	9.21±0.70^{a}	4.54±0.26^{a}	4.84±0.54^{a}	2.58±0.32^{a}	21.17±1.31^{a}
WB	9.18±0.86^{a}	4.46±0.38^{a}	4.37±0.42^{b}	1.85±0.10^{b}	19.86±1.01^{b}

- Data are mean ± SE for three replicates
- Means with different superscripts differed significantly ($P \leq 0.05$)

Table 9. The sensory properties of ghee prepared from milk (MG) and from Ras cheese whey (WG).

Ghee	Appearance (5)	Odour (5)	Flavour (5)	Texture (5)	Total (20)
MG	5.10±0.07^{a}	4.04±0.04^{b}	4.03±0.15^{b}	5.00±0.10^{a}	18.20±2.31^{a}
WG	4.11±0.16^{b}	4.56±0.18^{a}	4.65±0.16^{a}	4.47±0.14^{b}	17.72±3.01^{a}

- Data are mean ± SE for three replicates
- Means with different superscripts differed significantly ($P \leq 0.05$)

CONCLUSION

In conclusion, acceptable fatty dairy products (cream, butter, and ghee) could be manufactured successfully from Ras cheese salt whey, especially for ghee. Since the total sensory evaluation of whey ghee (WG) was almost the same as that of milk ghee (MG). It is quite important to recover valuable milk constituents from the salted whey on one side and to minimize the environmental pollution on the other side.

REFERENCES

Abd El-Aziz, M. (2008). Properties of butter oil fractions and its formulated emulsions. Egyptian J. Dairy Sci., 36: 53-61.

Aly, A. H. (2009). Fatty acid composition, textural and organoleptic properties of whey butter. J. Agric. Sci., Mansoura Univ., 34: 3081-3094.

AOAC. (2016).Official methods of analysis. 20th Ed.; Association of official Analytical Chemists: Rockville: International.

Awad, S.; Ahmed, N. and El-Soda, M. (2013). Application of salt whey from Egyptian Ras cheese in processed cheese making. Food Nutr. Sci., 4: 79-86.

Ayad, E. H. E.; Heraz, A. A; Awad, S. A. and Darwish, S.M. (2011). Development of processed cheese spread using Ras cheese whey, soybean flour and palm oil. Egyptian J. Dairy Sci., 39: 243-252.

Bodyfelt, F.W.; Tobias, J.; Trout, G.M. (1988). The sensory evaluation of dairy products. AVI Book, Published by Van Nostrand Reinhold, New York.

Bohdziewicz, K. (2006). Quality of whey fat obtained during the production of some ripening cheese. Polish J. Food Nutr. Sci., 15: 56: 29-33.

Brighenti, M.; Govindasamy-Lucey, S.; Jaeggi, J. J; Johnson, M. E. and Lucey, J. A. (2021). Effect of substituting whey cream for sweet cream on the textural and rheological properties of cream cheese. J Dairy Sci., 104, 10500-10512. doi: 10.3168/jds.2021-20338. Epub Jul 30. PMID: 34334199.

Caric, M.; Milanovic, S. and Vucelja, D. (2002). Standard methods for milk and milk products analysis. Novi Sad, Srbija.

Choi, H. S.; Yang, X.; Kim, D. S.; Yang, J. H.; Han, S. O.; Park, C. and Kim, S. W. (2020). Power generation from cheese whey using enzymatic fuel cell. J. Clean. Prod, 254: 120181. http://dx.doi.org/10.1016/j.jclepro.2020.120181.

Codex Alimentarius. Codex standard for butter. (2003). Codex Stan 279-1971 Rev 1-1999. FAO, WHO, Rome.

Davis, J. G. and Macdonald, A. I. C. (1953). Richmond´s Dairy Chemistry. 5th Ed., Charles Griffin & Co. Ltd, London.

El-Ghandour, A. A. (2015). A study on utilization of whey cream with reconstituted skim milk in manufacture of Tallaga cheese. J. Food Industries Nutr. Sci., 5: 51-62.

Elleuch, L.; Salem-Berrabah, O. B.; Cherni, Y.; Sghaier-Hammami, B.; Kasmi, M.; Botta, C.; Ouerghi, I.; Franciosa, I.; Cocolin, L.; Trabelsi, I. and Chatti, A. (2020). A new practical approach for the biological treatment of a mixture of cheese whey and white wastewaters using Kefir grains. Environmental Sci. and Pollution Res. Inter., 27: 33127-33139. http://dx.doi.org/10.1007/s11356-020-09549-8.

El-Tanboly, E.; El-Hofi, M.; Youssef, Y. B.; El-Despki, W. and Ismail, A. (2013). Utilization of salt whey from Egyptian Ras cheese (Cephalotyer) cheese in microbial milk clotting enzymes production. Acta Sci. Pol Technol. Aliment., 12: 9-19.

Faucher, M.; Perreault, V.; Gaaloul, S. and Bazinet, L. (2020). Defatting of sweet whey by electrodialysis with bipolar membranes: Effect of protein concentration factor. Sep. Purif. Technol., 251: 117248. http://dx.doi.org/10.1016/j.seppur.2020.117248

Frank, G.J. F; Christn, G.L. and Bullerunman, L. B. (1992). Tests for groups of microorganisms. In: Standard Methods for the Examination of Dairy Products. pp 271–286. Marshal R T ed. Washington, DC: American Public Health Association.

González-Siso, M. I. (1996). The biotechnological utilization of cheese whey: A review. Biores. Technol., 57: 1-11.

Gray, J. I. Measurement of lipid oxidation: A review. (1978). J. Amer. Oil Chm., 55: 539-546.

Guo, M. and Wang, G. History of Whey Production and Whey Protein Manufacturing. (2019). In: Whey Protein Production, Chemistry, Functionality, and Applications; Guo, M., Ed.; JohnWiley & Sons: Hoboken, NJ, USA, pp. 1–12.

Hae-Soo, K.; Ganesan, P. and Al Mijan, M. (2013). Butter, Ghee, and Cream Products. Milk and Dairy Products. In: Human Nutrition: Production, Composition and Health, First Edition. Edited by Young W. Park and George F.W. Haenlein.

Hebatalla, A.; Kheadr, E.; Dabour, N.; El Saadany, K.; El-Zieny, M.; Zedan , M. (2018). Buttermilk: One of the oldest functional foods (Review). Egyptian J. Dairy Sci., 46: 11-30.

Izzo, L.; Luz, C.; Ritieni, A.; Mañes, J. and Meca, G. (2020). Whey fermented by using Lactobacillus plantarum strains: A promising approach. J. Dairy Sci., 103: 5906-5915. http://dx.doi.org/10.3168/jds.2019-17547

Jay, J. M. (2000). Modern Food Microbiology. 6th Ed. Chapman and Hall, New York, NY, USA.

Jensen, R.G. (2002). The composition of bovine milk lipids: January 1995 to December 2000. J. Dairy Sci., 85: 295–350.

Jinjarak, S.; Olabi, A.; Jime´nez-Flores, R. J. and Walker, H. (2006). Sensory, functional, and analytical comparisons of whey butter with other butters. American J. Dairy Sci. Assoc., 89: 2428–2440.

Johnson, M. J.; Bradley, R. L. and Wendorff, W. L. (1997). Efficient use of whey cream in cheese making. UW Dairy Alert!, 10: 1 – 7.

Karaca, Y.; Gün, I.; Seydim, A. C. and Guzel-Seydim, Z. B. **(**2018**).** Production and quality of kefir cultured butter. Mljekarstvo**,** 68, 64-72. http://dx.doi.org/10.15567/mljekarstvo.2018.0108

Khalifa, M. Y. and Mansour, A. A. (1988). Physical, chemical and organoleptic properties of butter oil fractions. Egyptian J. Dairy Sci., 16: 47-54.

Kotoulas, A.; Agathou, D.; Triantaphyllidou, I.E.; Tatoulis, T.I.; Akratos, C.S.; Tekerlekopoulou, A.G. and Vayenas, D.V. (2019). Second Cheese Whey Treatment Using Zeolite under Continuous Flow Mode and Its Application on Wheat Growth. Water, 11: 928. [CrossRef]

Kumar, A.; Tripathi, S.; Hans, N.; Pattnaik, H. S. N. and Naik, S. N. (2018). Ghee: its properties, importance and health benefits. Lipid Univ., 6: 6–14.

Macwan, S. R.; Dabhi, B. K.; Parmar, S. C. and Aparnathi, K. D. (2016). Whey and its utilization. Inter. J. Current Micro. Applied Sci., 5: 134-155. http://dx.doi.org/10.20546/ijcmas.2016.508.016.

Marshall, R. T. (1992). Standard methods for the examination of dairy products, 16th Ed. Washington, DC: American Public Health Association.

Mehanna, N. M.; El-Wahsh, N. A. and Abd El-Aziz, A. M. (2018). Impact of some heat treatments and adjustment of casein/fat ratio of cheese milk on the yield and the rheological properties of Ras cheese. Egyptian J. Dairy Sci., 46 (Supplement), S21-S30.

Mehanna, N. M.; Khalifa, M. Y.; Saker, H.S.; Magouz, O. F. (2020). Profiling and some properties of fermented buttermilk peptides. Egyptian J. Dairy Sci., 48: 13-21.

Mehanna, N. M.; Moussa, M. A. M. and Abd El-Khair, A.A. (2008). Improvement of quality of Ras cheese made from pasteurized milk using special slurry from ewe´s milk. Arab Univ. J. Agric. Sci,, Ain-Shams Univ. Cairo, 6: 427-436.

Metwally, M. M.; El-Adb, M. M.; El-Dieb, S. M. and Metwally, A. M. M. (2001). Physical and chemical modifications of butter oil and its effect on rats serum and tissues lipids. 1: Thermal fractionation and interesterification of butter oil. Egyptian J. Dairy Sci., 29: 193-205.

Morin, P.; Pouliot, Y. and Jiménez-Flores, R. A. (2006). Comparative study of the fractionation of regular buttermilk and whey buttermilk by microfiltration. J. Food Engin., 77: 521-528,https://doi.org/10.1016/j.jfoodeng.2005.06.065.

Mortensen, B. K. (2011). Butter and other milk fat products. In*:* Encyclopedia of Dairy Sciences, 2nd Ed.; J.F Fuquay, P.F. Fox & P.L.H. McSweeney, Academic Press, London, Vol. 1, pp. 492–499.

Nadeem, M.; Mahud, A.; Imran, M. and Khalique, A. (2015). Enhancement of the oxidative stability of whey butter through almont (Prunus dulcis) peel extract. J. Food Process. Preserv., 39: 591-598. http://dx.doi.org/10.1111/jfpp.12265

Nelson, J.A.; Trout, G.M. (1981). Judging dairy products. 4th Ed., AVI Publishing Company, INC, Westport, Connecticut, USA.

Ostertag, F.; Schmidt, C.M.; Berensmeier, S. and Hinrichs, J. (2021). Development and validation of an RP-HPLC DAD method for the simultaneous quantification of minor and major whey proteins. Food Chem., 342: 128176. [CrossRef]

Panghal, A.; Patidar, R.; Jaglan, S.; Chhikara, N.; Khatkar, S. K.; Gat, Y. and Sindhu, N. (2018). Whey valorization: Current options and future scenario–a critical review. Nutrition Food Sci., 48: 520-535. http://dx.doi.org/10.1108/NFS-01-2018-0017

Parodi, P. W. (1999). A bold new look at milk fat, conjugated linoleic acid, and other anticarcinogenic agents of bovine milk fat. J. Dairy Sci., 82: 1339.

Pena-serna, C. and Restrepo-betancur, L. F. (2020). Chemical, physicochemical, microbiological and sensory characterization of cow and buffalo ghee. Food Sci. Technol., 1-7. doi.org/10.1590/fst.32219.

Pokorny, J.; Valentova, H. and Davidek, J. (1985). Modified determination of 2- thiobarbituric acid value in fats and oils. Die Nahrung, 29: 31-8. For TBA.

Rama, G. R.; Kuhn, D.; Beux, S.; Maciel, M. J. and Souza, C. F. V. (2019). Potential applications of dairy whey for the production of lactic acid bacteria. Inter. Dairy J., 98: 25-37. http://dx.doi.org/10.1016/j.idairyj.2019.06.012

Sanderson, W. P.; Brady, A. P.; Whitehead, G. F.; Oldham, I. J.; Brockwell, I. P. (1994). Recycling salt solution. In: cheese processing and apparatus therefore. Murray Goulburn Co- Operative Co. Limited, Australia, Assignee, US, 73: P. 237.

Shi, Y.; Smith, C. M.; Hartel, R. W. (2001). Compositional Effects on Milk Fat Crystallization. J. Dairy Sci., 84: 2392.

Smithers, G. W. (2015). Whey-ing up the options–Yesterday, today and tomorrow. Inter. Dairy J., 48: 2-14. http://dx.doi.org/10.1016/j.idairyj.2015.01.011

SPSS. (2016). SPSS for Windows. Statistical Package for Social Studies Software (SPSS, 2016); version 24; IBM Corp.: Armonk, NY, USA.

Trindade, M. B.; Soares, B.C.V.; Scudino, H.; Guimarães, J.T.; Esmerino, E. A.; Freitas, M.V.; Pimentel, T.C.; Silva, M. C.; Souza, S. L. Q.; Almada, R. B. and Cruz, A. G. (2019). Cheese whey exploitation in Brazil: A questionnaire survey. Food Sci. Technol. (Campinas), 39: 788-791. http://dx.doi.org/10.1590/fst.07419

Tsermoula, P.; Khakimov, B.; Nielsen, J. H. and Engelsen, S. B. (2021). WHEY-The waste-stream that became more valuable than the food product. Trends in Food Sci. Technol., 118; 230-241. http://dx.doi.org/10.1016/j.tifs.2021.08.025

Zommara , M. A. ; Mansour , A. A.; Ghanimah , M. A. (2018). Impact of dry fractionation of anhydrous milk fat made by the Egyptian boiling method on tissue lipid profile and plasma peroxidation stress of albino rats. Egyptian J. Dairy Sci., 46 (Supplement). S41-S50.

استخدام شرش جبن الراس المملح في صناعة منتجات الألبان الدهنية

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الملخص

شرش جبن الراس هو منتج ثانوي يتم إنتاجه أثناء تصنيع الجبن. يحتوي على مكونات غذائية صحية عديدة تساوي تقريبا نصف القيمة الغذائية للبن. ومع ذلك ، فإنه لا يتم لإستفادة منه علي الوجه الأكمل منه. الهدف من هذه الدراسة هو استخدام شرش جبن الراس المملح في تصنيع بعض المنتجات الدهنية مثل القشدة والزبدة والسمن. تم تحليل المنتجات الناتجة ومقارنتها مع تلك المصنوعة من لبن الأبقار. أوضحت النتائج المتحصل عليها أنه في علي الرغم من أن الريع في قشدة الشرش كانت أقل بكثير من قشدة اللبن ، إلا أنه كان أعلى بكثير في زبد الشرش (82.12%) مقارنة بزبد اللبن (65.84%) كما لم يكن هناك فرقا معنويا في الريع الخاص بالسمن الناتج من الشرش واللبن. كانت قشدة الشرش ذو قيم أقل بالنسبة للبروتين واللاكتوز ولكنه كان ذات نسبة حموضة وجوامد صلبة كلية ودهن ورماد أعلى من قشدة اللبن. كما لوحظت فروق بسيطة في إجمالي المواد الصلبة ومحتوى الدهن في زبد الشرش مقارنة بزبد اللبن ، بينما كانت نسبة الحموضة والرماد في زبد الشرش أعلى مقارنة بزبد اللبن. كانت أنواع الأحماض الدهنية مختلفة في السمن الناتج حيث احتوى سمن الشرش على نسبة أعلى من الأحماض دهنيه قصيرة ومتوسطة السلسلة مقارنة بالسمن الناتج من اللبن ، بينما لوحظ العكس فيما يتعلق بالأحماض الدهنية طويلة السلسلة. تميز السمن الناتج من الشرش بقيم أعلى معنويا بالنسبة لكل من رقم التصبن ، قيمة الحامض ، قيم ريخارت و بولينسكى بينما كانت قيم الاستر وحمض الثيوباربيتوريك (TBA) أقل قليلا مقارنة بالسمن الناتج من اللبن. وكانت الخصائص الحسية الإجمالية للقشدة الناتجة من الشرش أقل بكثير مقارنة بقشدة اللبن، بينما كانت خصائص زبد الشرش قريبة جدا لزبد اللبن. بالإضافة إلى ذلك، لم يكن هناك أى أختلاف معنوي بين الخصائص الحسية للسمن الناتج من الشرش والناتج من اللبن. وقد وجد أن أعداد البكتيريا والخميرة الفطر أعلى في القشده والزبدة الناتج من شرش اللبن مقارنة بتلك الناتج من اللبن. كما لوحظ أن جميع العينات محل الدراسة كانت خالية تماما من بكتريا القولون.

الكلمات الداله: الشرش ، القشدة، الزبد، السمن، الاحماض الدهنية