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Effect of Adding Glucono-δ-Lactone, Different of Starters, Rennet on the Chemical Composition, Yield and Economic Study of Kareish Cheese

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Abstract Kareish cheese was made from pasteurized skim buffalo's milk, divided into twenty-four equal portion and applying coagulation by used three types of starters (local yoghurt starter "L", ABT starter "A" and natural yoghurt "N") and replaced by the same percentage of the starter reciprocated with acidification was carried out with glucono-δ-lactone (GDL) with an amount of 0.5%, 1.0% and 1.5%, respectively, and added 0.05 ml rennet. Kareish cheese was analyzed for main chemical composition, organoleptic properties, yield and economic evaluation. L treatments showed a decrease in moisture, solid not fat content (SNF), salt in water phase contents and pH values, but an increase in fat in dry matter (FDM) and total protein (TP) contents, than A and N treatments. Also, treatments ARG3 and NRG3 were characterised by low contents of FDM, TP and pH values, but high contents of moisture, while, the treat LRG3 was characterised by high contents of TP and salt in water phase percentage, while, N treatments showed a decrease in total volatile fatty acids (TVFA), FDM and TP contents, but the A treatments showed an increase in TS content. The correlation coefficients between chemical analysis of cheese and whey output different treatments were positive and highly significant ($p<0.001$) in most relations. Finally, L treatments resulted in the highest overall yield, organoleptic properties and economic benefits, when the cheese outcome of the NRG_3 treatment was poor in this property, whilst, the cheese outcome of probiotic starter gave acceptable properties.

Keywords Kareish cheese – Starter, GDL – Skim milk – Rennet

1. Introduction

Cheese is an important integral part of diet consumed in Egypt. It is consumed almost three times a day. There are many traditional local cheese type produced in local regions. Kareish, Karish or Kariesh cheese is one of the most popular local type of fresh soft cheese in Egyptian cities and Arabian countries, similar to Domiati [1, 15]. It is an acid coagulated fresh cheese, made from skim milk with soft composition, white curd and slightly salty [27], it is made from skimmed buffalo's or cow's milk or a mixture of both [5], but mostly produced from skim buffaloes' milk and depends on its manufacturing on acid coagulation by the action of lactic acid bacteria [12]. The production of Kareish cheese is seasonal during winter and spring, the surplus of the cheese is stored in the very salty emulsion known as Mish, for preservation and supplying the farms family with cheese during summer and autumn. Kareish cheese has high protein content and makes a balanced meal when mixed with some vegetable oil and fresh pieces of tomato [54]. Mainly manufactured by smallholders and sold at local markets. As with other varieties of low/reduced fat cheeses, its consumption is still low because of poor perception of a product, based on inadequate taste and texture. In fact, the low fat cheese in general, has a low intensity of typical flavour bitter taste and hard rubbery dry grainy texture. Therefore, the challenge in development of low fat cheese is to improve both flavour attributes and texture of product to produce a cheese comparable to its full fat counterpart [9]. Kareish cheese was manufactured by using different types of dairy starter cultures [21]. It is now regarded as a medical diet for many patients. In traditional method for making Kareish cheese in farms, fresh buffaloes' milk was left for one or two days in earthenware pots at room temperature, the cream is separated by gravity and the partly skimmed milk (1.0-2.5% fat) is naturally coagulated by the wild lactic acid bacteria. The mats used for whey drainage allow some part of the curd lost into the whey and the resultant cheese is characterized by its short shelf life as a result of microbial contamination. On the other side, when sterilized cloth bags were used to whey ladling, the shelf life of Kareish cheese increased [35]. The traditional method for Kareish cheese production affords many opportunities for microbial

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contamination. It is generally made from raw skim buffalo's or cow's milk, which is often of poor bacteriological quality owing to the high microbial load present in raw milk and the unsatisfactory conditions under which it is produced [14]. Also, this product is sold uncovered and without container where the risk of contamination is high. Therefore, it can be considered as a good medium for the growth of different types of spoilage and pathogenic microorganisms [17, 53]. It is mainly manufactured by small holders and sold at the local market. Thus, the product is exposed to contamination with several types of microorganisms, especially with yeasts [36]. The fermentation of milk with lactic acid bacteria (production of fermented products: yogurt and acid-curd cheese varieties) and acidification with organic and inorganic acids are regularly used for acidic coagulation of milk [31]. During the last 20 years, milk acidification with glucono-δ-lactone has been commonly used for investigating changes that occur on casein micelles during gel formation. The structure of casein micelle undergoes intensive change during acidic coagulation of milk as discussed elsewhere [18, 26, 43]. Glucono-δ-lactone is an acidulant often abbreviated to GDL. GDL hydrolyses in water to form gluconic acid. The rate of acid formation is affected by temperature, concentration and the pH of the solution. It has low acid release at room temperature, but the rate of conversion to gluconic acid increases as the temperature increases [26]. GDL is readily soluble in water and is used in a range of applications. It is thought to be one of the best acids to reduce pH without giving an excessive acidic flavour profile of the food product [41]. For Kareish cheese production, milk is acidified by starter bacteria which slowly ferment lactose to lactic acid, causing a gradual decrease in pH. For research purposes, however, direct addition of acids such glucono-δ-lactone is often used. The gradual pH-dropping effect obtained by GDL hydrolysis mimics bacterial fermentation, although the rate of acidification during the initial stages is different. GDL hydrolysis leads to a rapid initial pH drop, whereas with bacterial cultures a lag period is observed prior to the rapid pH drop [18]. According to [42], the difference in the rate of acidification at this critical initial stage causes some modifications in structural properties of GDL-acidified gels compared to gels acidified with bacteria. The main aims of this study was to evaluate the effect of GDL addition, coagulation enzymes and different of starters on the chemical composition, yield and economic study of Kareish cheese.

2. Material and Methods

2.1. Materials

Fresh buffalo's milk was obtained from the dairy department, Faculty of Agriculture, Damietta University, Damietta, Egypt. Local yoghurt starter culture consists of *Streptococcus salivarius supsp. thermophilus* and *Lactobacillus delbruckii supsp. bulgaricus* 1:1. The ABT starter culture (*Lactobacillus acidophilus* LA-5, *Bifidobacterium* BB-12 and *Streptococcus thermophiles*) was obtained from Chr. Hansen's laboratories, Denmark. And natural starter were obtained from local market. Glucono-δ-lactone (GDL) was produced by Roquette Freres Company (Lille-France). It was added to the milk as a powder at a rate of 0.5, 1 and 1.5% (w/w). Calcium chloride "flakes 77%" made in Sweden was imported by kemira kemi AB, Helsingborg. Salt "Iodized Salt", produced by El-Nasr Saline's Co., Alex. Liquid calf rennet was obtained from local market and was added to milk at a ratio of 0.5 ml. per 100 kg milk. Potassium sorbate imported by Gersy Commercial Co. "Alex.", production by Z.K.W. China.

2.2. Kareish Cheese Making

Table 1. Chemical composition of skim buffalo's milk use to make Kareish cheese

	F (%)	TS (%)	pH	SNF (%)	Lactose (%)	TP (%)
Skim buffalo's milk	0.96	11.62	6.51	9.92	5.06	4.51

Buffalo's skim milk was pasteurization at 65±1ºC for 30 min, and then cooled to 32±1ºC. The chemical composition of skim milk is given in Table 1. The treated milk inoculated with three types of starter for cheese, which were added in ratio 3% in milk at 32±1ºC until curdling and considered it as a control for each treatment (without any additives).

Milk cheese, divided into 24 equal portions, we have 3 portions without any additives as control and 21 portions fortified with GDL and Rennet as follow:

First starter was used is "local yoghurt starter (L) and replaced by the same percentage of the starter reciprocated of GDL (G) and added 0.05 ml rennet (R) as follows:

1. Control (L): Kareish cheese made from 3% local yoghurt starter (L).
2. LG_1: Kareish cheese made from 2.5% L starter+0.5% GDL.
3. LG_2: Kareish cheese made from 2% L starter+1.0% GDL.
4. LG_3: Kareish cheese made from 1.5% L starter+1.5% GDL.
5. LR: Kareish cheese made from 3% L starter+0.05ml rennet/kg.
6. LRG_1: Kareish cheese made from 2.5% L starter+ 0.5% GDL + 0.05ml rennet/kg.
7. LRG_2: Kareish cheese made from 2% L starter+1.0% GDL + 0.05 ml rennet/kg.
8. LRG_3: Kareish cheese made from 1.5% L starter+ 1.5% GDL + 0.05 ml rennet/kg.

Second starter was used is ABT starter (A) and replaced by the same percentage of the starter reciprocated of GDL (G) and added 0.05 ml rennet (R) as follows:

9. Control (A): Kareish cheese made from 3% ABT starter (A).

10. AG_1: Kareish cheese made from 2.5% ABT starter + 0.5% GDL.
11. AG_2: Kareish cheese made from 2% ABT starter + 1.0% GDL.
12. AG_3: Kareish cheese made from 1.5% ABT starter + 1.5% GDL.
13. AR: Kareish cheese made from 3% ABT starter + 0.05 ml rennet/kg.
14. ARG_1: Kareish cheese made from 2.5% ABT starter + 0.5% GDL+0.05ml rennet/kg.
15. ARG_2: Kareish cheese made from 2% ABT starter + 1.0 % GDL+0.05 ml rennet/kg.
16. ARG_3: Kareish cheese made from 1.5% ABT starter + 1.5% GDL+0.05ml rennet/kg.

Third starter was used is natural starter (N) and replaced by the same percentage of the starter reciprocated of GDL (G) and added 0.05 ml rennet (R) as follows:

17. Control (N): Kareish cheese made from 3% natural starter from good quality Kareish cheese.
18. NG_1: Kareish cheese made from 2.5% natural starter + 0.5% GDL.
19. NG_2: Kareish cheese made from 2% natural starter + 1.0% GDL.
20. NG_3: Kareish cheese made from 1.5% natural starter + 1.5% GDL.
21. NR: Kareish cheese made from 3% natural starter + 0.05 ml rennet/kg.
22. NRG_1: Kareish cheese made from 2.5% natural starter + 0.5% GDL+0.05ml rennet/kg.
23. NRG_2: Kareish cheese made from 2% natural starter + 1.0% GDL+0.05 ml rennet/kg.
24. NRG_3: Kareish cheese made from 1.5% natural starter + 1.5% GDL+0.05ml rennet/kg.

The formed curd was ladled into wooden frames lined with muslin cloth, 2.5% salt was dispersed. Resultant cheese was stored at refrigerated temperature 5±1ºC for 14 days. Kareish cheese was taken out and weighted then the cheese of every treatment and packed in foam dishes with a capacity of 1kg, this method similar that [23] with some differences.

2.3. Chemical Analysis of Skim Milk and Cheese Samples

Total solids (TS), fat, total nitrogen (TN), lactose content, soluble nitrogen (SN) and non-protein nitrogen (NPN) of milk and cheese samples were determined according to [8], pH was determined with a digital pH meter (Hanna AT 4817), salt (S) of milk and Kareish cheese samples was measured according to [40]. Total volatile fatty acids (TVFA) were determined according to [38]. Salt contents of ingredients were estimated using Volhard method according to [49]. Total carbohydrates were calculated as described by [16].

2.4. Sensory Analyses

Organoleptic evaluation was carried out according to the scheme of [13]. Kareish cheese samples were subjected to organoleptic analyses by 20 staff members of the dairy, Microbiology and Food Science Departments (Faculty of Agriculture, Damietta University, Cairo, Egypt). The sensory attributes evaluated were: flavour (1–10 points), body and texture (1–5 points) and appearance and colour (1–5 points).

2.5. Statistical Analyses

PROC GLM procedure of the Statistical Analysis Systems [50] was used to analyze the Least-squares means (LSM) and standard errors (SE) in each level of treatments and the differences between means were detected by Duncan`s multiple range test [19]. Correlation coefficient analyzed with original data.

3. Results and Discussion

3.1. Chemical Composition of Cheese and Whey output from Kareish

Chemical composition of fresh Kareish cheese manufactured by various ways is presented in Table 2. The results revealed that, the way used in milk coagulation was affected on the chemical composition ($p<0.05$) of the resultant cheese. Kareish cheese made with local yoghurt starter (L) showed a decrease in moisture, solid not fat content, salt in water phase contents and pH values, but an increase in fat in dry matter (FDM) and total protein (TP) contents, than cheese with probiotic starter (A) and natural starter (N) treatments. Also, Kareish cheese made with starter and rennet (ARG_3 and NRG_3) was characterised by low contents of F/DM, TP and pH values, but high contents of moisture, while, the treat LRG_3 was characterised by high contents of TP and salt in water phase percentage, as compared with cheeses with starter only (L, A and N). Kareish cheese made with natural starter (N) showed a decrease in total volatile fatty acids (TVFA), fat in dry matter (F/DM) and total protein (TP) contents, but the Kareish cheese made with probiotic starter (A) showed an increase in total solids (TS) content. The Kareish cheese contains most of skim milk constituents, including 16.70% of protein, 3.98% of sugar, 72.50% of water and 0.1% of fat [5]. These results were agreed with the result obtained by [37], and the values of F/DM, moisture and protein of Kareish cheese of treatments fall in the range of the values stated by [22] (Fat/DM > 10%, moisture > 75%, protein < 10%).

Results presented in Table 2 indicated that the TVFA and pH values of Kareish cheese gradually decreased with increase ratios of GDL in all treatments, pH decrease agreement with [21, 45]. The TS and SNF contents gradually increased with increase ratios GDL except cheese samples made with probiotic starter and rennet (ARG_1, ARG_2, ARG_3 and NRG_1, NRG_2, NRG_3) were decrease contents of TS and SNF may be due to increased pH values in cheese samples, while, the increasing in TS and SNF contents in treats with starter and rennet due to the action of rennet and the

expulsion of whey. Similar trends were found by [4, 28, 37]. Also, [21] mentioned that the use of different bacterial strains resulted in a slight effect on moisture content of Kareish cheese. This might be due to the activity of mixed strains for producing acidity. The pH value of milk decreased faster when concentration of GDL was increased. These results agree with those of [20].

As indicated in Table 3 with regard to between fresh cheese components and each other, the correlation coefficients were positive and highly significant ($p<0.001$) in most relations, with the exception of coefficients were negative between pH value and TS and F/DM contents, SNF content, TP content, Salt in water phase percentage, TVFA content and pH value ($p<0.001$).

Table 2. Chemical composition in fresh Kareish cheeses made with various starters, GDL and rennet

Treatment	F/DM (%)	TS (%)	pH value	SNF (%)	TP (Nx6.38) (%)	Salt in water phase (%)	TVFA*
L	15.22^{a}	23.65^{bcde}	4.45^{hg}	20.05^{k}	17.29^{f}	2.75^{ji}	6.3^{abc}
LG_1	15.26^{a}	24.24^{bcda}	4.43^{h}	20.54^{j}	16.90^{ih}	2.86^{ghi}	6.4^{ab}
LG_2	14.89^{a}	25.52^{ab}	4.40^{h}	21.72^{gh}	17.86^{d}	3.08^{ef}	6.6^{a}
LG_3	14.76^{a}	25.75^{ab}	4.36^{h}	21.95^{gf}	17.99^{d}	3.36^{cb}	6.6^{a}
LR	10.00^{ghi}	23.00^{bcdef}	5.43^{cb}	20.70^{j}	15.64^{j}	2.85^{ghi}	5.5^{dghijef}
LRG_1	10.16^{gh}	24.60^{bcda}	5.40^{cd}	22.10^{fe}	16.71^{h}	3.05^{efg}	5.7^{bcdefg}
LRG_2	10.85^{f}	25.80^{ab}	5.32^{d}	23.00^{c}	17.55^{e}	3.09^{cb}	5.9^{abcdefg}
LRG_3	10.83^{f}	27.70^{abcd}	5.30^{d}	24.70^{a}	18.82^{b}	3.32^{cbd}	5.9^{abcdefg}
A	12.99^{cd}	23.85^{bcd}	5.44^{cb}	20.75^{j}	17.16^{fg}	3.02^{gfh}	6.0^{abcdef}
AG_1	13.69^{b}	24.82^{abcd}	5.41^{cd}	21.42^{ih}	17.86^{d}	3.19^{cdef}	6.2^{abcd}
AG_2	13.50^{cb}	25.92^{ab}	5.33^{d}	22.42^{eb}	18.63^{c}	3.73^{a}	6.3^{abc}
AG_3	13.97^{b}	27.19^{a}	5.29^{d}	23.39^{d}	19.58^{a}	3.43^{b}	6.5^{a}
AR	9.93^{hi}	22.15^{cdef}	5.55^{a}	19.95^{k}	15.25^{k}	2.69^{ijk}	5.4^{efghijk}
ARG_1	9.57^{jhi}	21.95^{cdef}	5.53^{a}	19.85^{k}	15.12^{k}	2.56^{jkl}	5.3^{fghijk}
ARG_2	9.76^{hi}	20.50^{ef}	5.51^{ab}	18.50^{m}	14.16^{l}	2.52^{kl}	5.0^{hijk}
ARG_3	9.50^{jhi}	20.00^{f}	5.50^{ab}	18.10^{n}	13.78^{m}	2.38^{kl}	4.9^{ijk}
N	10.90^{gf}	23.85^{bcd}	4.53^{g}	21.25^{i}	15.76^{j}	3.02^{lm}	5.9^{cdefghi}
NG_1	11.23^{f}	24.93^{abc}	4.45^{hg}	22.13^{ef}	16.46^{i}	3.13^{efd}	6.1^{abcde}
NG_2	12.00^{e}	25.82^{ab}	4.41^{h}	22.72^{cd}	17.03^{g}	3.23^{bcde}	6.1^{abcde}
NG_3	12.60^{ed}	26.18^{bcdef}	4.37^{h}	22.88^{c}	17.29^{f}	3.25^{bcde}	6.3^{abc}
NR	9.55^{jhi}	22.00^{cdef}	4.82^{e}	19.90^{k}	14.10^{l}	2.82^{ih}	5.2^{ghijk}
NRG_1	9.30^{ji}	21.50^{def}	4.79^{ef}	19.50^{l}	13.78^{m}	2.67^{ijk}	5.0^{hijk}
NRG_2	9.00^{jk}	20.00^{f}	4.75^{ef}	18.20^{mn}	12.76^{n}	2.50^{klm}	4.8^{jk}
NRG_3	8.55^{k}	19.88^{f}	4.70^{f}	18.18^{mn}	12.69^{n}	2.31^{m}	4.7^{k}
p-value	≤ 0.001	≤ 0.001	≤ 0.001	≤ 0.001	≤ 0.001	≤ 0.001	≤ 0.001
± *SE*	0.21	0.98	0.03	0.12	0.05	0.06	0.22

***** Total volatile fatty acids expressed as ml NaOH (0.1N) /100 gm cheese.

Table 3. Correlation coefficient among chemical compositions of fresh Kareish cheese

	F/DM (%)	TS (%)	pH value	SNF (%)	TP (Nx6.38) (%)	Salt in water phase (%)	TVFA*
Fat/Dry Matter (%)	-	0.522***	-0.367**	0.400***	0.730***	0.516***	0.797***
Total Solids (%)		-	-0.135^{ns}	0.677***	0.734***	0.700***	0.628***
pH value			-	-0.054^{ns}	-0.011^{ns}	-0.058^{ns}	-0.292**
Solid Not Fat (%)				-	0.860***	0.884***	0.632***
Total protein (Nx6.38) (%)					-	0.839***	0.787***
Salt in water phase (%)						-	0.660***
TVFA*							-

Table 4. Chemical compositions of whey output from different treatments to Kareish cheese

Treatment	Fat/Dry Matter (%)	Total Solids (%)	pH value	Solid Not Fat (%)	Lactose (%)	Total protein (Nx6.38) (%)
L	4.59^{c}	3.92^{a}	4.71^{g}	3.74^{a}	1.04^{o}	1.88^{c}
LG_1	4.32^{fe}	3.70^{b}	4.50^{hi}	3.54^{bc}	1.15^{n}	1.87^{c}
LG_2	3.96^{m}	3.53^{bcd}	4.48^{hi}	3.39^{e}	1.20^{m}	1.93^{b}
LG_3	3.49^{o}	3.43^{cdef}	4.39^{j}	3.31^{f}	1.29^{l}	1.98^{a}
LR	3.41^{p}	2.93^{ijkl}	5.23^{cb}	2.83^{k}	1.91^{ab}	0.78^{ml}
LRG_1	3.21^{q}	2.80^{kl}	5.10^{d}	2.71^{m}	1.85^{cd}	0.80^{ml}
LRG_2	2.94^{r}	2.72^{l}	4.98^{e}	2.64^{n}	1.81^{d}	0.75^{m}
LRG_3	2.48^{s}	2.42^{m}	4.89^{f}	2.36^{o}	1.67^{hi}	0.51^{n}
A	4.30^{fg}	3.72^{ab}	5.31^{ab}	3.56^{b}	1.81^{d}	1.58^{d}
AG_1	4.11^{k}	3.65^{bc}	5.29^{abc}	3.50^{cd}	1.75^{fe}	1.57^{d}
AG_2	4.22^{i}	3.55^{bcd}	5.22^{cb}	3.40^{e}	1.71^{fgh}	1.53^{ed}
AG_3	4.11^{k}	3.41^{def}	5.06^{ed}	3.27^{fg}	1.66^{i}	1.48^{ef}
AR	3.73^{n}	2.95^{efg}	5.33^{a}	2.84^{k}	1.94^{a}	0.77^{m}
ARG_1	4.26^{h}	3.05^{ih}	5.22^{bc}	2.92^{j}	1.88^{cb}	0.79^{ml}
ARG_2	4.81^{b}	3.12^{igh}	5.22^{bc}	2.97^{ij}	1.82^{d}	0.80^{ml}
ARG_3	5.62^{a}	3.20^{fgh}	5.20^{c}	3.02^{i}	1.76^{e}	0.83^{kl}
N	4.42^{d}	3.62^{bcd}	4.55^{h}	3.46^{d}	1.71^{fgh}	1.48^{ef}
NG_1	4.27^{hg}	3.51^{bcde}	4.52^{ih}	3.36^{e}	1.65^{i}	1.47^{f}
NG_2	4.42^{d}	3.39^{edf}	4.51^{ih}	3.24^{g}	1.61^{j}	1.43^{f}
NG_3	4.35^{e}	3.22^{fgh}	4.44^{ij}	3.08^{h}	1.57^{k}	1.31^{g}
NR	4.16^{j}	2.88^{jkl}	4.80^{f}	2.76^{l}	1.68^{igh}	0.87^{kj}
NRG_1	4.07^{l}	2.95^{ijk}	4.70^{g}	2.83^{k}	1.72^{fg}	0.89^{j}
NRG_2	4.34^{e}	2.99^{ijkh}	4.68^{f}	2.86^{k}	1.77^{e}	0.95^{i}
NRG_3	4.81^{b}	3.12^{igh}	4.65^{f}	2.97^{ij}	1.88^{bc}	1.08^{h}
p-value	≤ 0.001	≤ 0.001	≤ 0.001	≤ 0.001	≤ 0.001	≤ 0.001
± *SE*	0.01	0.07	0.03	0.02	0.01	0.02

Table 5. Correlation coefficient among chemical compositions of whey output from different Treatments to Kareish cheese

	F/DM (%)	TS (%)	pH value	SNF (%)	Lactose (%)	TP (Nx6.38) (%)
F/DM (%)	-	0.490***	-0.043^{ns}	0.482***	0.071^{ns}	0.242*
TS (%)		-	-0.278**	0.945***	-0.504***	0.840***
pH value			-	-0.343**	0.579***	-0.529***
SNF (%)				-	-0.572***	0.907***
Lactose (%)					-	-0.756***
TP (Nx6.38) (%)						-

Table 4 illustrates the main chemical composition of whey output to Kareish cheese manufactured by various ways. The results revealed that, the way used in acidification by GDL adding and rennet were affected on the chemical composition ($p \leq 0.05$) of the resultant whey cheese. Whey Kareish cheese result with local yoghurt starter (L) showed a decrease in TS, F/DM, SNF contents and pH values in mostly treatments, but an increase in lactose and TP contents in the treatments without rennet, than whey cheese result with probiotic starter (A) and natural starter (N).

Also, whey cheese made with starter, GDL and rennet (LR, AR and NR) was characterised by low contents of TS, F/DM, SNF, TP and pH values, but high contents of moisture and lactose content, as compared with whey's with starter and GDL only (LG, AG and NG). The increasing of F and SNF content in whey's is due to the increase in dry matter.

Positive and significant estimates of correlation coefficients between chemical compositions of whey output

different treatments to Kareish cheese ranged from 0.242* among TP and F/DM to 0.945*** between TS and SNF, while negative estimates ranged from -0.278** between pH and TS to -0.756*** between lactose content and TP. On the other hand negative and positive non-significant estimates emerged between F/DM with pH and lactose content (r=-0.043 and 0.071, respectively) as noticed in table 5.

3.2. Organoleptic Evaluation

The Kareish cheeses were evaluated for flavour, appearance and colour, and body and texture. Data pertaining to the overall evaluation and preference of fresh Kareish cheese are depicted in Table 6. The results of the sensory evaluation of fresh Kareish cheese manufactured by various ways cleared that treatments L gained higher score for appearance, body and texture and flavour than treatments A and N at zero time. Where the type of starter and way used in milk coagulation were the principle factors influencing the sensory properties of cheeses prepared. Kareish cheeses made with probiotic starter (ABT) was more accepted by the panelists (rich flavour and creamy body and texture), as compared with cheese made by local yoghurt starter or natural starter. Differences between treatments were affected by the type of starter, GDL adding and rennet. Kareish cheese made with natural starter, rennet and 1.5% GDL (NRG_3) had the lowest score (10.57) out of 20, compared with Kareish cheese made with ABT starter (A) without GDL or rennet had higher score (14.67) out of 20 for sensory evaluation than the other treatments followed by L and AG_1 (14.57), LG_1 and AG_2 (13.99), respectively. Kareish cheese made with different starters and GDL (0.5%) was judged better than that with acidified (1.0 or 1.5%) GDL. Kareish cheese made from GDL without rennet addition had a good quality (soft and moist-texture). The quality of Kareish cheese was decreased with GDL and rennet addition, increased, beside the cheese made from ABT starter fortified with GDL had a good quality especially with AG_1 (0.5% GDL). The results indicate that the addition of GDL (not more than 0.5%) to control was enough to obtained Kareish cheese with a good quality near to that made from starter only without GDL or rennet addition.

Table 6. Organoleptic properties of Kareish cheese made from different treatments

Treatment	Appearance and Color (5)	Body & Texture (5)	Flavour (10)	Total (20)
L	4.67±0.01	5.00±0.58	4.90±0.25	14.57
LG1	4.33±0.01	4.86±0.01	4.80±0.06	13.99
LG2	4.00± 0.58	4.71±0.01	4.70±0.06	13.41
LG3	3.67±0.01	4.57±0.01	4.60±0.06	12.84
LR	4.00±0.58	4.29±0.01	4.60±0.06	12.89
LRG1	3.67±0.01	4.14±0.01	4.50±0.06	12.31
LRG2	3.33±0.01	3.86±0.01	4.40±0.06	11.59
LRG3	3.00±0.58	3.86±0.01	4.30±0.06	11.16
A	4.67±0.01	5.00±0.58	5.00±0.58	14.67
AG1	4.67±0.01	5.00±0.58	4.90±0.25	14.57
AG2	4.33±0.01	4.86±0.01	4.80±0.06	13.99
AG3	4.00±0.58	4.71±0.01	4.60±0.06	13.31
AR	4.00±0.58	4.57±0.01	4.70±0.06	13.27
ARG1	3.67±0.01	4.43±0.01	4.60±0.06	12.70
ARG2	3.33±0.01	4.29±0.01	4.50±0.06	12.12
ARG3	3.33±0.01	4.14±0.01	4.30±0.06	11.78
N	4.33±0.01	4.86±0.01	4.60±0.06	13.79
NG1	4.00±0.58	4.57±0.01	4.50±0.06	13.07
NG2	3.67±0.01	4.43±0.01	4.40±0.06	12.50
NG3	3.00±0.58	4.29±0.01	4.20±0.06	11.49
NR	3.67±0.01	4.14±0.01	4.40±0.06	12.21
NRG1	3.67±0.01	4.00±0.58	4.20±0.06	11.87
NRG2	3.33±0.01	3.86±0.01	4.10±0.06	11.29
NRG3	3.00±0.58	3.57±0.01	4.00±0.58	10.57

Values of textural were higher in cheese made with the probiotic starter (ABT) than those of other treatments, which made by local yoghurt starter or natural starter. The higher values of textural in cheese made by ABT could be related to its lower moisture content [7]. [11] suggested that high moisture weakens the protein network resulting in a less firm cheese. The high moisture content and weak protein network produce smooth cheese that coats the mouth during mastication [7]. [10] found that Kareish cheese made from milk and inoculated with ABT starter had the best organoleptic properties, nutritive value and lower production costs.

Generally, Kareish cheese made with different starters and GDL had got the highest scores in body & texture (smooth and compact) compared with rennet only or with GDL, which could be attributed to rennet added. The use of the starter culture in cheese manufacture resulted in some improvements in flavour and aroma development [32]. Also, [28, 29] mentioned that the flavor intensity score of cheeses that had probiotic bacteria which added individually was slightly higher than that of the other cheese produced by local yoghurt starter or natural starter, which was probably due to the combination of the higher concentrations of lactic and acetic acids and of free amino acids and soluble peptides.

According to the panelists, cheese manufactured with probiotic starter (ABT) received more score points. As shown, the use of this probiotic starter enhanced the flavour and improved body and texture of the treated carries cheese when compared with the other starters. The cheese containing ABT as probiotic starter exhibited the highest score and improved flavour compared with two starters (L and N) and other treatments with additives. It was characterized by good nature flavour, typical smooth body and texture. It was followed by cheese made with local yoghurt starter (L) then natural starter (N). Mentioned that the lowest values of textural in Kareish cheese, may be due to the increase in cheese moisture content. Also, [48] indicated that relative amounts of water, protein, and fat were the dominant factors electing cheese hardness. Fat and moisture act as the filler in the casein matrix of cheese texture [44], giving it lubricity and softness. Increasing the concentration of GDL or rennet inoculated milk also decreased cheese fracture stress and made the cheese body weaker.

3.3. Yield and Coagulation Time of Kareish Cheese

Coagulation time

Table 7. Effect of percent GDL on time coagulation and cheese yield

Treatments	G.D.L %	Coagulation time (minutes)	Cheese yield %
L	-------	240	27.7
LG_1	0.5	200	25.20
LG_2	1.0	180	24.60
LG_3	1.5	85	24.00
LR	-------	75	26.10
LRG_1	0.5	60	24.30
LRG_2	1.0	50	23.15
LRG_3	1.5	40	22
A	-------	245	26.5
AG_1	0.5	205	24.2
AG_2	1.0	190	23.1
AG_3	1.5	90	22
AR	-------	70	24.25
ARG_1	0.5	60	23.01
ARG_2	1.0	55	21.52
ARG_3	1.5	38	20
N	-------	180	22
NG_1	0.5	175	23.32
NG_2	1.0	160	24.20
NG_3	1.5	80	25.60
NR	-------	70	23.00
NRG_1	0.5	60	22.90
NRG_2	1.0	50	22.30
NRG_3	1.5	35	21.82

Table 8. Economic evaluation of cheese samples

Ingredients	Skim Milk (Kg)	Starter 1 (Gram)	Starter ABT (Gram)	Starter Local (Gram)	Salt (Kg)	Local rennet (Kg)	Citric acid (Kg)	Calcium chloride (Kg)	GDL (Kg)	Potassium Sorbate (Kg)	Total Price (LE)
Price (L.E.)	4.00	0.12	0.0125	0.0125	0.5	20.00	20.00	18.00	60.00	48.00	
L	200	3.60	0.375	0.375	1.25	--	10.00	0.40	--	2.40	218.4
LG_1	200	3.00	0.3125	0.3125	1.25	--	10.00	0.40	30	2.40	247.675
LG_2	200	2.40	0.25	0.25	1.25	--	10.00	0.40	60	2.40	276.95
LG_3	200	1.80	0.1875	0.1875	1.25	--	10.00	0.40	90	2.40	306.225
LR	200	3.60	0.375	0.375	1.25	0.10	10.00	0.40	--	2.40	218.5
LRG_1	200	3.00	0.3125	0.3125	1.25	0.10	10.00	0.40	30	2.40	247.775
LR_{G2}	200	2.40	0.25	0.25	1.25	0.10	10.00	0.40	60	2.40	277.05
LR_{G3}	200	1.80	0.1875	0.1875	1.25	0.10	10.00	0.40	90	2.40	306.325
A	200	3.60	0.375	0.375	1.25	--	10.00	0.40	--	2.40	218.4
AG_1	200	3.00	0.3125	0.3125	1.25	--	10.00	0.40	30	2.40	247.675
AG_2	200	2.40	0.25	0.25	1.25	--	10.00	0.40	60	2.40	276.95
AG_3	200	1.80	0.1875	0.1875	1.25	--	10.00	0.40	90	2.40	306.225
AR	200	3.60	0.375	0.375	1.25	0.10	10.00	0.40	--	2.40	218.5
ARG_1	200	3.00	0.3125	0.3125	1.25	0.10	10.00	0.40	30	2.40	247.775
ARG_2	200	2.40	0.25	0.25	1.25	0.10	10.00	0.40	60	2.40	277.05
ARG_3	200	1.80	0.1875	0.1875	1.25	0.10	10.00	0.40	90	2.40	306.325
N	200	3.60	0.375	0.375	1.25	--	10.00	0.40	--	2.40	218.4
NG_1	200	3.00	0.3125	0.3125	1.25	--	10.00	0.40	30	2.40	247.675
NG_2	200	2.40	0.25	0.25	1.25	--	10.00	0.40	60	2.40	276.95
NG_3	200	1.80	0.1875	0.1875	1.25	--	10.00	0.40	90	2.40	306.225
NR	200	3.60	0.375	0.375	1.25	0.10	10.00	0.40	--	2.40	218.5
NRG_1	200	3.00	0.3125	0.3125	1.25	0.10	10.00	0.40	30	2.40	247.775
NRG_2	200	2.40	0.25	0.25	1.25	0.10	10.00	0.40	60	2.40	277.05
NRG_3	200	1.80	0.1875	0.1875	1.25	0.10	10.00	0.40	90	2.40	306.325

Data in Table 7 shows the effect of percent GDL adding and rennet on time coagulation of Kareish cheese. Kareish cheese made ABT starter (A) without GDL or rennet had longer a coagulation time (245 minutes), compared with the Kareish cheese made with natural starter, rennet and 1.5% GDL (NRG_3) had shorter a coagulation time (35 minutes). This change was due to the action of rennet and GDL adding. In addition the use of GDL mixtures with rennet in all treatments decreased the coagulation time of Kareish cheese as compared with treatment without GDL. [20] concluded that higher concentration of GDL accelerated the onset time of gelation and the rate of network formation. The character of casein micelles influences forces that control gelation, therefore, changes on casein micelle depend on both temperature and pH value [26]. Hydrophobic interactions, which play the most significant role in gelation of casein micelle, are favoured at higher temperatures [30]. The coagulation time for the unsalted cheese was longer than that of the salted cheese, this could be due to the mineral elements introduced into the milk through the addition of salt that hastened the coagulation of the salted milk [47].

Cheese yield

Cheese yield is affected by many factors, including milk composition, amount and genetic variants of casein, milk quality, milk pasteurization, coagulant type, vat design, curd firmness at cutting, and manufacturing parameters [25, 39, 41, 51].

Results presented in Table 7 show the fresh yield of Kareish cheese made from different starter fortified with GDL or rennet by different ratio. The cheese yield decreased with the increasing of GDL or rennet addition. Also, the fresh yield of Kareish cheese made from ABT acidified with GDL was higher than that made from GDL mixtures with rennet. Kareish cheese made from local starter yoghurt (L) resulted in the highest overall yield (27.7%) at fresh, when compared with the cheese made from natural starter (NRG3), which had the lowest cheese yield (21.82%). These results might be due to the effect of GDL and rennet addition. It was noticed that the cheese made from natural starter acidified

with GDL had higher yield when compared with control (without any addition) and treatment made from GDL mixtures with rennet. [52] found that, in the acid coagulation at pH 4.6 all proteose-peptones (pp) are lost in the whey, in the rennet coagulation three quarters of them, that are pp5 and pp8 are retained in the curd, contributing to increase the cheese yield. The yield of Kareish cheese fortified with GDL were higher than the yield of cheese fortified with GDL mixtures with rennet in all different starter treatments, as well as coagulation time was highly decreased when GDL mixtures with rennet, this might attributed to the increase in acidity, which led to an increase in whey separation and increase the curd force. Increase of the gel firmness and average force measured. This might be due to the increase of web gel stability. Adding GDL alone to Mozzarella cheese milk decrease both actual and moisture and salt adjusted cheese yields more than using GDL with yoghurt starter as acidulate. The progressive reduction in moisture and salt adjusted cheese yield with increasing pre-acidification was caused by a substantial reduction in calcium recovery in the cheese and a tendency for decreased protein recovery in the cheese. This would decrease moisture and salt adjusted yield [34, 46].

The increase in yield of cheese could be explained by the denaturation and precipitation of whey proteins and/or by the higher retention of water in the soft curd formed [2, 55]. [6 and 3] reported a high yield of milk cheese between 19-19.2% in soft cheese. The yield values of treatments were within the values reported by other researchers [12, 33].

The expression of cheese yield is important in the economic control of cheese-making and in expressing results of the experiments. The usual way is as "kg of cheese per 100 kg of milk". It is important that the composition of milk and cheese (and whey) be given because they markedly affect yield. It is recommended that actual yield be compared with the theoretical yield to estimate yield efficiency (actual yield as percentage of theoretical yield). The definition of cheese yield, or how to express yield, is important in two main applications: 1. Economic control of cheesemaking; 2. Expressing the results of cheesemaking experiments [24]. Data in Table 8 show the simple economic analysis for incorporation of GDL in analogue Kareish cheese manufacture. The costs of the ingredients used in the examined blend and the total price as well as the net profit were illustrated in Table 8. It could appear that by increasing the concentration of GDL added to the blend of Kareish cheese the net profit decreased.

Table 9. Economic evaluation of Kareish cheese samples

Treatments	Coast			Price of Kareish (LE)	Gain	Gain (%)
	Ingredients in 100 Kg*	Processing 20%	Total			
L	218.4	43.68	262.08	554	291.92	52.69
LG_1	247.67	49.54	297.21	504	206.79	41.03
LG_2	276.95	55.39	332.34	492	159.66	32.45
LG_3	306.22	61.25	367.47	480	112.53	23.44
LR	218.50	43.70	262.20	522	259.8	49.77
LRG_1	247.77	49.56	297.33	486	188.67	38.82
LRG_2	277.05	55.41	332.46	463	130.54	28.19
LRG_3	306.33	61.26	367.59	440	72.41	16.45
A	218.40	43.68	262.08	530	267.92	50.55
AG_1	247.68	49.53	297.21	484	186.79	38.59
AG_2	276.95	55.39	332.34	462	129.66	28.06
AG_3	306.22	61.25	367.47	440	72.53	16.48
AR	218.50	43.70	262.2	485	222.8	45.94
ARG_1	247.77	49.56	297.33	460.2	162.87	35.39
ARG_2	277.05	55.41	332.46	430.4	97.94	22.75
ARG_3	306.325	61.265	367.59	400	32.41	8.10
N	218.40	43.68	262.08	440	177.92	40.44
NG_1	247.67	49.54	297.21	466.4	169.19	36.27
NG_2	276.95	55.39	332.34	484	151.66	31.33
NG_3	306.23	61.24	367.47	512	144.53	28.23
NR	218.50	43.70	262.2	460	197.8	43.00
NRG_1	247.77	49.56	297.33	458	160.67	35.08
NRG_2	277.05	55.41	332.46	446	113.54	25.46
NRG_3	306.33	61.26	367.59	436.4	68.81	15.76

* Price of 1kg Kareish in Egyptian market 20 LE.
* Price of 1Kg skim milk in Egypt 2 LE.

The costs of the ingredients used in the examined blends and the total price as well as the net profit are illustrated in Tables 8 and 9. It could be appeared that there was a relationship between the final cost of the blend and its composition. Kareish cheese made from milk with 4% WG and inoculated with yoghurt starter + *Lactococcus lactis subsp. lactis* had the best organoleptic properties, nutritive value and lower production costs [10].

4. Conclusions

Kareish cheese made from local starter yoghurt (L) resulted in the highest overall yield, organoleptic properties and economic benefits; when the cheese outcome of the NRG_3 treatment, it was poor in this properties, whilst, the cheese outcome of probiotic starter gave acceptable properties.

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