J. of Food and Dairy Sci., Mansoura Univ., Vol. 13 (1):25 - 31, 2022

Journal of Food and Dairy Sciences

Journal homepage & Available online at: www.jfds.journals.ekb.eg

Influence of Added Cassava Flour (*Manihot esculenta*) on the Properties of kareish cheese

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ABSTRACT

The effect of adding Cassava Flour (*Manihot esculenta*) CF on the yield, physicochemical, microbiological, rheological, and sensory properties of kareish cheese was studied. CF was added at 0.5%, 1%, and 1.5%. to skim milk used in making of kareish cheese. Addition of CF resulted in significant effect on fibers, protein, ash, moisture, acidity, and WHC contents of cheese. by increasing its concentration. Molds and yeasts did not appear in all treatments with added CF up to 29 days of cold storage, however they appear in control after 21 days. Results also showed a decrease in the numbers with an increase of added CF, compared with the control. Gradual increase in adhesiveness, gumminess, cohesiveness, chewiness, and springiness was observed with the increase of added CF, while an opposite trend was detected in the hardness. Significant increase in the yield of all treatments of cheese with added CF, compared with the control. From the above mentioned results, it could be concluded that addition of CF could be useful, especially at 1% in the making of functional Kareish cheese of with functional property and of high quality.

Keywords: Cassava flour, kareish cheese, yield, microstructure.

INTRODUCTION

Consumer awareness of the importance of a functional diet in preserving health is driving an increase in the consumption of functional foods around the world. As a result, the food industry has invested in developing alternative goods with modified compositions, such as removing or restricting the presence of certain health-harming substances. Crizel *et al.* (2014) and Salem *et al.* (2005). The development of these foods is difficult because they must match consumer desire for items that are both pleasant and healthful, as well as have qualities that are similar to traditional cuisines (Cruz *et al.*, 2009).

Kareish cheese is a popular traditional Egyptian dairy product that is delicious, soft, and healthful. It has nutritional and therapeutic value, is acceptable for all age groups, and plays a significant role in the treatment of obesity. Because of its high protein content, low fat content, and affordable price, it is often manufactured in the Egyptian countryside and used in their diet (Abou-Donia, 2008). It is also regarded as one of the most calcium and phosphorus-rich foods. These minerals are necessary for the creation of bones and teeth. Obesity, cholesterol, and heart disease sufferers are frequently advised to take it Fayed *et al.*, (2014) and Osman *et al.*, (2010).

Cassava is an essential part of the diets of more than 800 million people around the world, according to the Food and Agriculture Organization of the United Nations FAO,(2007), and is the third-largest carbohydrate food source in tropical regions, after rice and corn Ceballos *et al.* (2004) and Ceballos *et al.* (2006). It's also used to make starch, flour, drinks, animal feed, biofuels, and textiles, among other foods and non-food items (Tewe and Lutaladio, 2004).

Also, it is known to be a good and cheap source of carbohydrates. Earlier reports have shown that cassava flour blends have some functional properties due to which it can be used in bakery products. Consumption of bakery products has been increasing as a result of urbanization, and Food industries are exploiting this development by manufacturing nutritious bakery foods (Akubor, 2003).

The primary goal of this research is to make functional kareish cheese fortified with cassava flour to improve the microbial quality; physicochemical, rheological and sensory properties also, improving the microstructural of the cheese.

MATERIALS AND METHOD

Materials:

Fresh buffalo̓s skim milk was produced from Animal Production Research Institute, Agriculture Research Center, Dokki, Egypt. Yoghurt starter culture containing, *Lactobacillus delbrueckii ssp.,bulgaricus, Streptococcus thermophillus*, was obtained from MIRCEN Culture Collection Center, Faculty of Agriculture, Ain shams University, Egypt. Microbial rennet, Marzyme MT 2200 Powder, Dosage: 0.022g IMCU/L milk, were obtained from Danisco France SAS. Sodium chloride and Calcium chloride was obtained from El-Gomhoria Company, Cairo. Cassava roots (*Manihotesculenta* Crantz), Classification name: Misr1.were obtained from Crop Intensification Research Department (CIRD), Field Crops Research Institute (FCRI), and Agricultural Research Center (ARC).Table (1), shows the average composition of

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DOI: 10.21608/jfds.2022.121818.1038

Cassava flour (CF), fresh Buffalo skim milk used in the present study. These results agree (Randrianantenaina, A. *et al.*2020; Morgan, N.K. 2016; Awad, *et al.* 2015 ; Lu, H., *et al.* 2020 and Nteaina, *et al.* 2020).

Methods:

Cassava flour (CF) preparation: Fresh Cassava roots (*Manihot esculenta*) were cleaned, washed, peeled and sliced to chips, dried at 45±2°C for 3 days in incubator, and then ground to fine powder.

Preparation of Kareish Cheese:

Fresh skim buffalo milk
↓
Pasteurized at 72°C for 15sec.
↓
Cool to 40 - 42°C
↓
Added different levels of cassava flour (0.5-1-1.5%) with Added starter *Lactobacillus bulgarcicus, Streptococcus thermophillus* 1:1.
↓
After 20 min, added 0.022g/L Microbial rennet and 0.02% calcium chloride
↓
Incubated at 42°C for 2hours
↓
Pour cheese curd in Plastic frames and coated with gauze.
↓
Curds sprinkled with 1% Sodium chloride.
↓
Stored at 5°C in fridge for 24 hours
↓
Filtrated
↓
Cut off
↓
Packed
↓
Stored at 5°C in fridge for 29 days.

They were analyzed at 1, 8, 15, 22, and 29 days.

Kareish cheese was manufactured according to the method adopted by Effat *et al.* (2001).

Physicochemical analysis:

Moisture, fat, ash, salt, dietary fiber, titratable acidity (TA%), pH values (using pH meter, Jeneway) and total protein (TP) contents were determined in both raw materials and Kareish cheese samples according to the method described by AOAC (2012). The content of carbohydrate was calculated by the differences. The loss of protein in different treatments was calculated using the following equation:

$$\text{Protein loss \%} = \frac{\text{\% Protein in filtrate residual}}{\text{\% protein in pre cheese milk}} \text{ X } 100$$

Recovery of protein content in different cheese samples was calculated as follow:

Recovery of proteins % = 100 - protein Loss%

The yield of cheese is a mathematical expression for the quantity of cheese obtained from given quantity of raw materials as the formula given by Fox *et al.* (2000).

$$\text{Cheese yield\%} = \frac{\text{Amount of cheese(kg)}}{\text{Amount of original pre cheesemilk (kg)}} \text{ X } 100$$

Microbiological analysis:

Cheese samples were examined for total viable bacterial count, yeasts & molds according to American Public Health Association (ABHA, 2005).

Sensory evaluation:

Kareish cheese were Sensory evaluated for appearance, body & texture and flavor according to scheme described by IDF (1995).

Rheology analysis:

Syneresis and water holding capacity (WHC) Omojola, (2010).

Syneresis of kareish cheese is calculated by the formula:

Syn = S / Y.

S: The released serum was removed and weighed.

Y: 20 g from sample after cooling to 4±1 ° C in one day of storage were centrifuged for 5 minutes, 500 rpm in + 20°C.

The Water-holding capacity of kareish cheese is calculated by formula:

WHC = Y - W / Y x 100%.

Y: 20 g from sample after cooling to 4±1 ° C in one day of storage were centrifuged for 10 minutes at 3000 rpm, +20°C.

W: The released serum was removed and weighed.

The results are in grams of water/100 g of the Kareish cheese.

Texture profile analysis (TPA):

Texture profile analysis test of Kareish cheese samples was done using a Universal Testing Machine (TMS-Pro) equipped with 1000 N (250 lbf) load cell and connected to a computer programmed with Texture Pro^{TM} texture analysis software (program, DEV TPA withhold). Calculation described by Bourne (1978) was used to obtain the texture profile parameters.

Microstructure determination:

Following Brooker and Wells (1984) approach, different fresh Kareish cheese blocks (0.5 mm3) were made for scanning electron microscopy (SEM). SEM coated with gold-palladium membranes was used to examine the samples in a JEOL, Japan. The microscope, a JSM-6510 L.V SEM, was operated at 30 KV at the EM Unit of Mansoura University in Egypt.

Statistical analysis:

SAS software was used to statistically evaluate all of the data collected.

RESULTS AND DISCUSSION

Chemical composition of buffalo skim milk and cassava flour before preparation are shown in Table (1).

Data presented in Table (2) illustrate significant differences (P<0.0001) of kareish cheese fortified with cassava flour (CF) in moisture, protein, fiber contents of kareish cheese fortified with cassava flour (CF). Ash content increased by added CF. increasing the moisture, protein, fiber and ash content resulting from an increase in the addition of (CF). Therefore, by adding 1.5% (CF) had the highest moisture content, while the lowest of moisture content was the control treatment.

As shown in Table (2), the total composition of kareish cheese fortified with CF decreased in fat, carbohydrates and ash by decreasing the level of addition, and the differences between treatments in these components were significant to(P< 0.0001).

Table 1. The chemical composition of Cassava flour and Buffalo skim milk used in making of Kareish cheese formula.

Character assessed	Cassava flour	Buffalo skim milk
Moisture %	8.20	90.6
Protein %	2.17(Nx6.25)	4.11 (Nx6.38)
Ash %	2.3	0.97
Fat %	0.51	0.34
Total dietary fiber %	1.10	-
Available Carbohydrates %	85.72	Lactose 4.92
TitratableAcidity %	0.08	0.16
pH- value	6.83	6.61
Ca (mg/100g Dm)	842.02	169
P (mg/100g Dm)	258	106
Mn (mg/100gDm)	4.86	0.004
Mg (mg/100g Dm)	161.71	17
Zn (mg/100g Dm)	1.92	0.22
Fe (mg/100g Dm)	36.12	0.04
K (mg/100g Dm)	558	164

***Determined in 20% aqueous solution (w/v).**

It could also be observed that there were significant differences (P< 0.0001) in the length of the storage period up to 29 days in the all of the examined parameters. These findings came in agreement with those of Alnemr, *et al.* (2013) and RamziDhuol and Hamid (2013).

Table 2. The chemical composition of Kareish cheeses fortified with different Level of Cassava Flour (CF) during storage at 5±1°C.

Component (%)	Storage	Treatments: Levels of fortifying with CF (%)			
		Control (0)%	0.5 %	1 %	1.5 %
Moisture (%)	1	70.29^{Da}	72.74^{Ca}	75.15^{Ba}	77.32^{Aa}
	8	70.05^{Dba}	72.63^{Cba}	75.10^{Bba}	77.29^{Aba}
	15	69.65^{Dba}	72.50^{Cba}	75.02^{Bba}	77.26^{Aba}
	22	69.20^{Db}	72.38^{Cb}	74.94^{Bb}	77.18^{Ab}
	29	58.71^{Dc}	72.22^{Cc}	74.82^{Bc}	77.02^{Ac}
Fat (%)	1	1.15^{Ac}	1.09^{Bc}	1.02^{Cc}	1.00^{Cc}
	8	1.18^{Abc}	1.10^{Bbc}	1.02^{Cbc}	1.02^{Cbc}
	15	1.22^{Abc}	1.13^{Bbc}	1.05^{Cbc}	1.02^{Cbc}
	22	1.27^{Aba}	1.22^{Bba}	1.10^{Cba}	1.05^{Cba}
	29	1.35^{Aa}	1.25^{Ba}	1.20^{Ca}	1.10^{Ca}
Total Protein (%)	1	13.21^{Ad}	13.24^{Bd}	13.29^{Bd}	12.34^{Cd}
	8	13.25^{Ad}	13.26^{Bd}	13.30^{Bd}	12.34^{Cd}
	15	13.48^{Ac}	13.31^{Bc}	13.32^{Bc}	12.40^{Cc}
	22	13.81^{Ab}	13.40^{Bb}	13.38^{Bb}	12.42^{Cb}
	29	14.09^{Aa}	13.54^{Ba}	13.47^{Ba}	12.43^{Ca}
Fiber (%)	1	-	0.45^{Ca}	0.90^{Ba}	1.35^{Aa}
	8	-	0.45^{Ca}	0.95^{Ba}	1.35^{Aa}
	15	-	0.50^{Ca}	0.95^{Ba}	1.40^{Aa}
	22	-	0.55^{Ca}	1.00^{Ba}	1.46^{Aa}
	29	-	0.55^{Ca}	1.02^{Ba}	1.50^{Aa}
Carbohydrates (%)	1	13.16^{Ac}	10.07^{Bc}	6.95^{Cc}	5^{Dc}
	8	13.31^{Ab}	10.14^{Bb}	6.93^{Cb}	6.35^{Db}
	15	13.37^{Ac}	10.11^{Bc}	6.94^{Cc}	4.91^{Dc}
	22	13.36^{Ac}	9.59^{Bc}	6.83^{Cc}	4.85^{Dc}
	29	23.39^{Aa}	9.87^{Ba}	6.69^{Ca}	4.85^{Da}
Ash (%)	1	2.19^{Dc}	2.41^{Cc}	2.69^{Bc}	2.99^{Ac}
	8	2.21^{Dbc}	2.42^{Cbc}	2.70^{Bbc}	3.00^{Abc}
	15	2.28^{Dbac}	2.45^{Cbac}	2.72^{Bbac}	3.01^{Abac}
	22	2.36^{Dba}	2.50^{Cba}	2.75^{Bba}	3.04^{Aba}
	29	2.46^{Da}	2.57^{Ca}	2.80^{Ba}	3.10^{Aa}
Salt (%)	1	1.70^{Ad}	1.70^{Bd}	1.60^{Cd}	1.55^{Cd}
	8	1.80^{Ad}	1.74^{Bd}	1.62^{Cd}	1.60^{Cd}
	15	2.40^{Ac}	1.80^{Bc}	1.65^{Cc}	1.60^{Cc}
	22	2.60^{Ab}	1.88^{Bb}	1.71^{Cb}	1.65^{Cb}
	29	2.90^{Aa}	2.10^{Ba}	1.82^{Ca}	1.73^{Ca}

0.5, 1 and 1.5%, treatments with fortified cassava flour (CF) respectively. Control treatments without fortified CF. A,B,C,…. : Means with same capital letter in same character assessed for between treatments are not significantly different (p>0.0001). a,b,c,d : Means with same letter in the same character assessed among treatments in the same storage period are not significantly different (p>0.0001).

Loss and Recovery of protein or fat:

Loss and recovery of protein in fresh kareish cheeses fortified with different levels of CF were shown in Table (3). The protein content lost in 1.5% treatment was the lowest 11.37% while the protein content lost in the control treatment was as 21.16%.

Results in Table (3) also indicate that adding CF to kareish cheese resulted in a a significant (P < 0.0001) decrease in protein loss, came in harmony with El-Dardiry (2017). This could be due to dietary fiber and starch having desirable functional properties, such as improving crystallization, thickening texture,Stabilizing and emulsifying Nelson (2001). Cassava flour is considered to be rich in both. The starch and fiber may trap the protein in the cheese curds and reduce its release into the whey.

Table 3. Loss and recovery of protein in Kareish cheese fortified with different levels of Cassava flour.

Properties	Treatments with levels of fortified with Cassava flour (%)			
	Control (0)	0.5	1.0	1.5
Protein loss %	21.16^{A}	15.21^{B}	12.54^{C}	11.37^{D}
Recovery of protein%	78.84^{D}	84.79^{C}	87.46^{B}	88.63^{A}

Yield of kareish cheese:

Table (4) shows the yield percent of kareish cheese samples fortified with different levels of CF (4). The production of kareish cheese fortified by CF from various treatments was higher than control cheese. There were significant differences (P<0.0001) between kareish cheese treatments.

Data in Table (4) show that yield of cheese with added 1.5 % CF treatment increased by 55.56 %, compared to the control treatment, whereas the 1.0 % CF treatment increased cheese yield by 36.36 %, compared with the control. These results were similar to El-Dardiry (2017). This could be because dietary fibre has beneficial functional qualities in DF-enriched foods, such as texture, gelling, thickening, emulsification, and stability (Nelson, (2001), Agyemang, *et al.* (2020) and Wahyuni,*et al.* (2017).

Table 4. Yield % of Kareish cheeses fortified with different levels of Cassava flour during storage at 5±1°C.

Property	Treatments with levels of fortifying with Cassava flour (%)			
	Control (0)	0.5	1	1.5
Yield%	24.75^{D}	29.25^{C}	33.75^{B}	38.50^{A}
Increment%	-	18.18	36.36	55.56

pH value and Acidity (%)

Changes in the acidity of kareish cheese during the incubation period are shown in Table (5). The obtained data indicate an increase in acidity in all treatments including control during the storage period. This is expected due to the growth of microorganisms cultured in in milk. The growth of the starting microorganisms was lower in the permeability control treatment, compared to the other treatments. This might be due to the presence of the lactic acid bacteria that ferments cassava flour, resulting in tissue modification through cellular activity that disrupts cassava cell walls Amoa-Awua *et al.* (2014) and produces glutamate that improves the aroma of cassava flour. The activity of linamaras, which accelerates the release of cyanogenic glycoside, increases the rate of conversion of part of the starch in cassava flour to simpler sugars (hydrolysis). Lei *et* *al.* (1999). Part of these sugars are consumed by the starter culture bacteria, which leads to an increase in their activity, acceleration of acidity production, and coagulation of cheese in less period of coagulation. Kresnowati. *et al.* (2019).

Data illustrated in Table (5) show that adding 1.5% CF reduced the coagulation time to 30 minutes, whereas adding 1% CF increased the coagulation time to 60 minutes, and adding 0.5% CF increased the coagulation time to 90 minutes, which could be explained by the addition of cassava flour in making, kareish cheese fortified with cassava flour which of short time in coagulation. Kresnowati *et al.* 2019. It was also found that the control treatment had incubation at 120 minutes.

Table 5. Acidity development of Kareish cheeses fortified with different levels of Cassava flour during Incubation time after (min).

Incubation time after (min)	Treatments with levels of fortifying with Cassava flour (%)			
	Control (0)	0.5	1	1.5
0.0	0.27	0.32	0.39	0.45
30	0.34	0.61	0.89	coagulation
60	0.42	0.95	coagulation	coagulation
90	0.66	coagulation	coagulation	coagulation
120	0.93	coagulation	coagulation	coagulation

Results of Figs. 1 and 2 show that the control treatment had the lowest T.A%, while the treatment with CF 1.5% had higher value in T.A%, compared with all of the examined treatments. Moreover, The lowest significant pH ($p<0.0001$) detected in treatments fortified with CF. This might be attributed to an enhanced growth and activity of the starter culture by the addition of CF, which contains a very high proportion of starch. Prasad *et al.*, (2013) and Abbas *et al.* (2017).

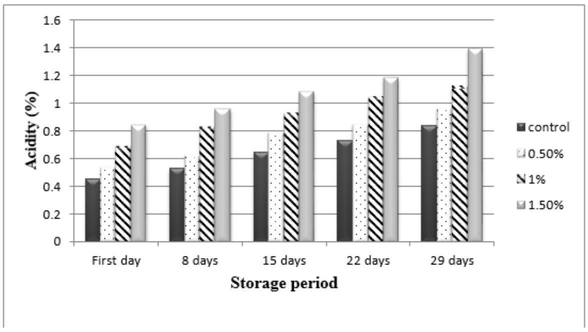

Fig 1. Titratable Acidity and pH of Kareish cheeses fortified with different level of Cassava flour during storage at 5±1°C.

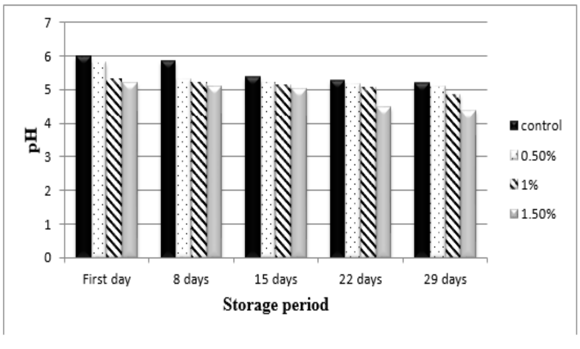

Fig 2. pH of Kareish cheeses fortified with different level of Cassava flour during storage at 5±1°C.

The results of Figs. 1 and 2 show that different significant ($p<0.0001$) in acidity between treatments of kareish cheese in pH value between treatments of cheese. Generally, by prolonging of cold storage period of kareish cheese treatments resulted in a significant increase ($p<0.0001$) in T.A% and significant reduction ($p<0.0001$) in pH value. These results were seems El-Bialy, *et al.* (2016) and Alnemr, *et al.* (2013).

Microbiological quality:

In Table (6) sow that mold and yeasts counts and TBC in Kareich cheese fortified with different concentrations of CF during storage. Molds and yeasts began to appear after 21days in control treatment; however, they were not detected in the treatments of fortified CF during prolonged storage period. Perhaps delaying the appearance of yeasts and fungi might be due to the addition of CF binds the water in the cheese, which reduces the chance of its growth Bi, W., *et al* (2016).

In the presence of CF, the total bacterial count (TBC) was lower than in the control sample (Table 6). It's possible that the results are due to the CF effect during the storage period. The total viable bacterial count, on the other hand, grew until 15 days, then declined until the end of the 29-day storage period. According to Sahan, *et al.* (2004), overall aerobic bacterial counts fell. During the period of storage these findings reveal that the most inhibitory effects were observed when CF was added in the highest quantity.

Table 6. Microbiological counts (log CFU/ mL) of Kareish cheeses fortified with different levels of Cassava flour during storage .

Cold storage period (days)	Treatments with levels of fortified with Cassava flour (%)			
	Control (0)	0.5	1.0	1.5
	Total bacterial counts (log CFU /g)			
1	5.89^{Ae}	4.64^{Be}	4.56^{Ce}	4.57^{De}
8	6.71^{Ad}	5.58^{Bd}	5.32^{Cd}	5.47^{Dd}
15	7.45^{Ac}	6.32^{Bc}	5.90^{Cc}	5.87^{Dc}
22	7.23^{Aa}	7.11^{Ba}	6.31^{Ca}	6.54^{Da}
29	6.99^{Ab}	6.84^{Bb}	6.00^{Cb}	6.49^{Db}
	Mold &Yeast counts (log CFU /g)			
1	-	-	-	-
8	-	-	-	-
15	-	-	-	-
22	3.98	-	-	-
29	4.72	-	-	-

Not detected (-)

Textural characteristic:

Table (7) shows that regarding syneresis, it was significantly lower ($P < 0.0001$) in the treatments kareish cheese containing CF compared with control. Moreover, throughout storage period. Syneresis significantly ($P < 0.0001$) decreased with increasing levels of CF. This could be attributed to the starch and fiber particles take up water from the surrounding protein matrix and would swell thereby limiting syneresis Lucey, (2001). The kareish cheese with CF had significantly ($P < 0.0001$) higher WHC % than the control due to the ability of starch and fiber in cassava flour to bind more water consequently, thus these gels exhibited a smoothness texture Lucey, (2001). Kareish cheese with 1.5% CF showed the highest WHC% followed by1% CF and 0.5% CF.

Results also revealed that, the addition of CF improved the increase of water holding capacity and minimize syneresis of kareish cheese which are in agreement with those reported by Guven. *et al.*, (2005), Ares *et al.*, (2007), Prasad *et al.*, (2013) and Lu, *et al.* (2020).

Table 7. Textural characteristic of kareish cheese fortified with different level of CF during storage at 5±1°C.

Component (%)	Cold storage period (days)	Treatments with levels of fortified with Cassava flour (%)			
		Control (0)	0.5%	1%	1.5%
WHC (%)	1	32.5^{Da}	35.6^{Ca}	37.1^{Ba}	38.9^{Aa}
	8	32.1^{Db}	35.0^{Cb}	37.0^{Bb}	38.6^{Ab}
	15	31.4^{Dc}	34.6^{Cc}	36.8^{Bc}	38.2^{Ac}
	22	30.8^{Dd}	34.1^{Cd}	36.7^{Bd}	37.5^{Ad}
	29	29.9^{De}	33.7^{Ce}	36.3^{Be}	37.2^{Ae}
Syneresis (g water/100g kareish cheese)	1	16.4^{Aa}	14.8^{Cc}	12.9^{Dd}	11.3^{Ee}
	8	16.0^{Aa}	14.1^{Cc}	12.7^{Dd}	11.0^{Ee}
	15	15.4^{Aa}	13.8^{Cc}	12.4^{Dd}	10.6^{Ee}
	22	14.6^{Aa}	13.0^{Cc}	11.9^{Dd}	10.4^{Ee}
	29	14.0^{Aa}	12.6^{Cc}	11.6^{Dd}	10.3^{Ee}

Texture profile analysis:

The results of hardness, gumminess, cohesiveness, chewiness, Adhesiveness and springiness of kareish cheese at the end of the storage period are tabulated in Table 8. The values of textural mentioned properties were significantly ($p< 0.0001$) affected by the CF used in kareish cheese production. Utilization of CF is used in fortified kareish cheese with high values of gumminess, Adhesiveness, cohesiveness, Chewiness and springiness, but low levels of hardness. Table (8) notes the results of all texture profile analysis are observed. There are significant differences ($p< 0.0001$) between the treatments and the length of the storage period. These findings are consistent with those of Abbas, *et al.*, (2017).

Table 8. Texture profile analysis (TPA) of Kareish cheeses fortified with different level of Cassava flour during storage at 5±1°C.

Textural Characterises	Cold storage period (days)	Treatments levels of fortified with Cassava flour (%)			
		Control (0)	0.5%	1%	1.5%
Hardness (N)	1	4.60^{Ae}	4.32^{Be}	4.01^{Ce}	3.85^{De}
	8	4.82^{Ad}	4.39^{Bd}	4.06^{Cd}	3.90^{Dd}
	15	5.22^{Ac}	4.51^{Bc}	4.24^{Cc}	4.00^{Dc}
	22	5.46^{Ab}	4.66^{Bb}	4.38^{Cb}	4.14^{Db}
	29	5.89^{Aa}	4.82^{Ba}	4.52^{Ca}	4.30^{Da}
Adhesiveness (mJ)	1	0.325^{Dd}	0.541^{Cd}	0.734^{Bd}	0.882^{Ad}
	8	0.352^{Dc}	0.671^{Cc}	0.921^{Bc}	1.240^{Ac}
	15	0.299^{Db}	0.792^{Cb}	1.243^{Bb}	1.721^{Ab}
	22	0.304^{Da}	0.954^{Ca}	1.472^{Ba}	1.892^{Aa}
	29	0.387^{Dba}	0.948^{Cba}	1.450^{Bba}	1.799^{Aba}
Cohesiveness (Ratio)	1	0.18^{Cc}	0.34^{Bc}	0.48^{Ac}	0.61^{Ac}
	8	0.23^{Cb}	0.46^{Bb}	0.62^{Ab}	0.68^{Ab}
	15	0.28^{Cba}	0.51^{Bba}	0.70^{Aba}	0.75^{Aba}
	22	0.36^{Ca}	0.60^{Ba}	0.78^{Aa}	0.83^{Aa}
	29	0.36^{Ca}	0.58^{Ba}	0.77^{Aa}	0.80^{Aa}
Springiness (mm)	1	1.67^{De}	3.24^{Ce}	4.15^{Be}	5.34^{Ae}
	8	1.89^{Dd}	3.69^{Cd}	4.45^{Bd}	5.49^{Ad}
	15	1.94^{Dc}	4.08^{Cc}	4.96^{Bc}	5.62^{Ac}
	22	2.11^{Db}	4.35^{Cb}	5.43^{Bb}	5.84^{Ab}
	29	2.28^{Da}	4.91^{Ca}	5.78^{Ba}	5.89^{Aa}
Gumminess (N)	1	0.828^{Dd}	1.469^{Cd}	1.925^{Bd}	2.449^{Ad}
	8	1.086^{Dc}	2.019^{Cc}	2.517^{Bc}	2.652^{Ac}
	15	1.462^{Db}	2.300^{Cb}	2.534^{Bb}	3.00^{Ab}
	22	1.966^{Da}	2.796^{Ca}	3.416^{Ba}	3.436^{Aa}
	29	2.120^{Da}	2.796^{Ca}	3.480^{Ba}	3.440^{Aa}
Chewiness (mJ)	1	1.383^{De}	4.760^{Ce}	7.989^{Be}	13.078^{Ae}
	8	2.053^{Dd}	7.450^{Cd}	11.201^{Bd}	14.559^{Ad}
	15	2.836^{Dc}	9.384^{Cc}	12.569^{Bc}	16.86^{Ac}
	22	4.148^{Db}	12.163^{Cb}	18.549^{Bb}	20.066^{Ab}
	29	4.834^{Da}	13.728^{Ca}	20.114^{Ba}	20.261^{Aa}

Microstructure of kareish cheese:

The scanning electron micrograph indicated that the shape, size, and distribution of the interstitial spaces of the loosened Kareish cheese texture varies with the level of cystic fibrosis added. Figure 3. The microstructure of kareish cheese affected by the fortifying of CF is shown in Figure 3. The microstructure analysis showed that the internal structure of kareish cheese made from cystic fibrosis was denser, cohesive, and smoother than the surfaces of the control sample (Fig. 3).

These discrepancies were most likely caused by hydrophobic interactions between casein micelles and stabilizers, which resulted in the creation of casein-stabilizer complexes. Wang *et al.*, (2012) When a low level of CF was introduced, it was limited to a dispersed phase and acted as a filler, resulting in a more compact protein Matrix, and increased kareish cheese gel strength.

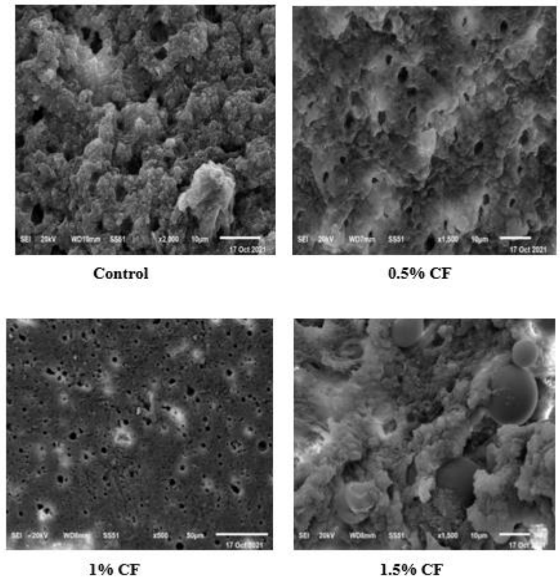

Fig. 3. Scanning electron microscopy of PC manufacture with different levels of Cassava flour.

The casein network in CF-treated kareish cheese was more consistently and smoothly dispersed, with a bit of a coarse structure and less porosity. According to Elohor Udoro, E.O., (2021) and Lorenzen *et al.* 2002. this could be due to hydrocolloids and emulsion stability catalysing cross-link synthesis between milk proteins less defined. These discrepancies were most likely caused by hydrophobic interactions between casein micelles and stabilizers, which resulted in the creation of casein-stabilizer complexes. Wang *et al.*, (2012). When a low level of CF was introduced, it was limited to a dispersed phase and acted as a filler, resulting in a more compact protein matrix, and increased kareish cheese gel strength.

Adding CF formed a stranded network from the protein phase. This probably explains the more compact texture observed in the kareish cheese made with CF (Fig. 3). These results are in agreement with Considine, *et al.* (2011) and El-Dardiry, *et al.* (2017).

Sensory evaluation

Table (9) represents the panel scores of the resulting kareish cheese, whether fresh or during cold storage. While there were no changes in appearance with the addition of CF to 1% of the milk prepared for making kareish cheese, it decreased slightly when 1.5% CF was added. The consistency and texture of the kareish cheese improved, and the cheese showed greater cutting ability by adding CF to the milk prepared for cheese making. Treatments of up to 1% showed adequate and good body strength while the body started to become stiffer with a higher incidence of CF. As in the results listed in Table (9), the flavor of kareish cheese became more preferred by the committee members with the addition of CF in the mixture by up to 1% compared to the control throughout the storage period. At 1.5%, the plates began to detect a cassava flavor.

The data also indicated that all Kareish cheese was acceptable, but the addition of CF in the milk up to 1% acquired better organoleptic quality compared to the control. Only one treatment 1.5% demonstrated significantly lower quality attributes when compared to other treatments. The sensory quality attributes of all treatments, including the control, decreased during the storage period. This data agrees with the findings of El-Dardiry, *et al.* (2017).

Table 9. Sensory evaluation of Kareish cheeses fortified with different level of Cassava flour during storage at 5±1°C.

Property	Cold storage period (days)	Treatments of levels of fortified with Cassava flour (%)			
		Control (0)	0.5	1	1.5
Appearance (15)	1	14^{Ca}	15^{Aa}	15^{Aa}	13^{Ba}
	8	13.5^{Cba}	15^{Aba}	15^{Aba}	13^{Bba}
	15	12^{Cb}	15^{Ab}	15^{Ab}	13^{Bb}
	22	10^{Cc}	15^{Ac}	15^{Ac}	12^{Bc}
	29	5^{Cd}	14^{Ad}	14^{Ad}	11^{Bd}
Body &texture (35)	1	33^{Ba}	35^{Aa}	35^{Aa}	35^{Aa}
	8	32^{Ba}	35^{Aa}	35^{Aa}	35^{Aa}
	15	30^{Bb}	35^{Ab}	35^{Ab}	35^{Ab}
	22	25^{Bc}	33^{Ac}	33^{Ac}	33^{Ac}
	29	20^{Bd}	30^{Ad}	30^{Ad}	30^{Ad}
Flavor (50)	1	47^{Ca}	45^{Aa}	45^{Aa}	40^{Ba}
	8	42^{Cb}	45^{Ab}	45^{Ab}	41^{Bb}
	15	41^{Cb}	45^{Ab}	45^{Ab}	41^{Bb}
	22	35^{Cc}	45^{Ac}	45^{Ac}	42^{Bc}
	29	20^{Cd}	45^{Ad}	45^{Ad}	40^{Bd}
Total (100)	1	94^{Ca}	95^{Aa}	95^{Aa}	88^{Ba}
	8	87.5^{Cb}	95^{Ab}	95^{Ab}	89^{Bb}
	15	83^{Cc}	95^{Ac}	95^{Ac}	89^{Bc}
	22	70^{Cd}	93^{Ad}	93^{Ad}	87^{Bd}
	29	45^{Ce}	89^{Ae}	89^{Ae}	81^{Be}

CONCLUSIONS

Great quality functional kareish cheese can be made by fortifying industrial milk with cassava flour up to 1%. because the resulted cheese takes a short time for coagulation & has a perfect texture & has a long shelf life and increase of resulted cheese yield. And this has economic importance for the production of kareish cheese.

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تأثيراضافة دقيق الكسافا على خواص الجبن القريش

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استهدفت الدراسة بيان تأثيرإضافة دقيق الكسافا على التصافى والخواص الفيزوكيميائية والميكروبية والريولوجية والحسية للجبن القريش. حيث تم إضافة دقيق الكسافا إلى اللبن الفرز المستخدم لصناعة الجبن القريش بنسب ٠,٥%، ١%، ١,٥% ، أدت إضافة CF تأثير معنوي على الألياف ، البروتين ، الرماد ، الرطوبة ، الحموضة ، والقدرة على الارتباط بالماء لمكونات الجبن. عن طريق زيادة تركيزه.أما بالنسبة للجودة الميكروبية فقد لوحظ عدم ظهور نموات الفطر والخمائرفى جميع المعاملات المضاف لها دقيق الكسافا حتى ٢٩ يوما من التخزين على درجة حرارة الثلاجة بينما ظهرت نموات فطرية وخمائر فى معاملة الكنترول بعد ٢١ يوما وبالنسبة للعدد البكتيرى فلوحظ انخفاضه بزيادة نسبة الاضافة مقارنة بالكنترول .وفيمايختص بخواص التركيب البنائى للجبن القريش والتى تشمل التلاصق،المطاطية،التصمغ والمضغ فجميعها أظهرت ارتفاعا تدريجيا بزيادة نسبة الإضافة بينما أظهرت صفة الصلابة اتجاه معاكس. ودعمت صور الميكروسكوب الإلكترونى نتائج خواص التركيب البنائى. كما أوضحت النتائج أن جميع معاملات الجبن القريش كانت مقبولة حسيا خاصة نسب 0.5 % , 1%. بالنسبة للتصافى النتائج أظهرت زيادة معنوية فى الجبن القريش المدعم بدقيق الكسافا بالتركيزات السابق ذكرها وكانت نسبة التصافى فى الجبن الناتج أعلى مقارنة بعينات الكونترول.ومما سبق نوصى بإستخدام دقيق الكسافا فى انتاج جبن قريش وظيفى ذو جودة عالية ذات خصائص حسنة حتى نسبة ١%.