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Chemical, Microbiological and Sensory Evaluations of Some Imported Hard Cheese Semi-Hard Cheese

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Imported hard cheese and semi-hard cheese, lactose fermentation, lipolysis, proteolysis, chemical composition, and sensory evaluations.

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ABSTRACT

Five different samples (three replicates) of imported hard cheese and semi-hard cheese (Roquefort, Gouda, Edam, Cheddar and Lugriri cheese) were collected from different sources of Port Said Governorate. Microbiological, chemical, and sensory evaluations were conducted. The highest value of total bacteria count was 3105 cfu/g, and the lowest value was 585 cfu/g in Gruyere (Lugriri) cheese and Cheddar cheese, respectively. The highest value of the total count of fungi was 15000 cfu/g in Edam cheese and the lowest value was 125 cfu/g in Roquefort and Cheddar cheese. Coliform found in all samples, except Roquefort cheese. Also, *Salmonella* and *Shigella* did not found in all samples. All cheese samples did not contain *Staphylococcus* or *Clostridium*. In regard to chemical composition, pH was varied from 5.90 to 4.89 for Roquefort and Edam cheese, respectively. The lowest value of salt percentage was 1.52 and 1.42 in red cheddar cheese and Lugriri, respectively. Fat varied from 34.98% to 21.22% in Lugriri and Gouda cheese, respectively. The highest value of moisture was recorded at 52.85% in Gouda cheese and the lowest value was 35.87% in Lugriri cheese. The highest value of protein was in Lugriri cheese (28.95%), and the lowest value was in Roquefort cheese (20.01%). The highest percentage of lactose was found in Lugriri cheese, and the lowest percentage of lactose was found in Edam cheese being 2.61% and 1.08%, respectively

INTRODUCTION

Hard cheeses and semi-hard cheese are a major source of protein in many western countries. Yet there has been disagreement between experts and laymen over what represents 'quality'. Whereas, for most foods and beverages, there is a consensus, consumers may have definite opinions about factors such as the structure and texture of cheeses that may not be regarded as important by food technologists **(Jack and Paterson, 1992)**. Hard cheeses are ripened after manufacture for periods ranging from a few months to two or more years and have ripening period for flavor and texture characteristic of the variety develop. It is often difficult to differentiate between the flavors of freshly made curds of different types of hard cheeses immediately after manufacture **(Jo et al., 2018)**. Cheese texture is influenced greatly by manufacture that largely determines the moisture content of the cheese and its calcium and fat and fat-in-dry-matter levels. However, texture changes during ripening due to solubilization of calcium phosphate, hydrolysis of the casein matrix, changes to water binding within the curd, and loss of moisture caused by evaporation from the cheese surface (**Abd Elmontaleb *et al*., 2020)**. While certain changes during the ripening of hard and semi-hard cheeses are always considered defects, such as late gas blowing, others are considered problems only if they exceed certain limits (**Zerfiridis *et al*.,1984)**. For example, very low levels of bitterness are normal in the flavor profile of cheeses, such as Cheddar, and are not considered a defect unless levels of bitter peptides exceed certain limits. Likewise, lipolysis occurs during the ripening of all hard and semi-hard cheeses **(Ulpathakumbura *et al*., 2016)**. Hence, balanced ripening is essential to the quality of hard and semi-hard cheeses **(Weinrichter *et al*., 2000)**. Cheese is a ready-to-eat food, which may be contaminated on the surface by undesirable spoilage and pathogenic microorganisms at the production, packaging, and post-packaging processes. *Penicillium roqueforti* is commonly found on cheese surfaces at refrigerator temperatures, and is one of the most common spoilage fungal species. *Listeria monocytogenes* has been associated with food-borne listeriosis by consumption of cheese. Therefore, there is a need for decontamination of cheese at post-processing stages **(Can *et al*., 2014)**. The current study focused on five kind of cheese, BIue or blue veined cheese (Roquefort type) is semi soft or semi hard cheese represents a cheese type of

considerable commercial importance in the United States **(Gripon, 1993)**. Gouda cheese is a washed-curd Dutch cheese that is traditionally produced from bovine milk **(Jo et al., 2018).** Edam cheese, a semi hard cheese variety, is one of the main types of cheese manufactured in Netherlands, which is manufactured in the form of sphere loaf and ripened for two weeks to around two years. Cheddar is one of the most popular cheese varieties in the world due to its characteristic flavor and texture and is classified as a hard to semi-hard cheese **(Abd Elmontaleb, 2020).** Swiss cheese made in Greece is either from ewes' milk without starters or from cows' milk with starters. The latter cheese is mostly Lugriri, which has a more intense flavor than the typical Gruyere imported from other European countries. There for this study aims to evaluate the microbiological, chemical, and sensory of some imported had cheese or semi hard such as Roquefort, Gouda, Edam, Cheddar and Lugriri cheese.

MATERIAL AND METHODS

Collecting sample of imported hard cheese:

Five different samples (three replicates) of imported hard cheese or semi hard (Roquefort, Gouda, Edam, Cheddar and Lugriri cheese) were collected from different sources of Port Said Governorate.

Microbiological media and cultivation methods:

Five cultivation media were used for microbiological evaluations. Poured plate method **(Benson, 2011)** was used for total bacterial count, total fungal count, *Staphylococci* and *Salmonella Shigella* count. Serial dilutions were carried out , one ml was plated in triplicates into sterilized glass Petri dish. About fifteen ml of melted media (nutrient agar, potato dextrose agar, staph 110, SS medium, respectively) **(Ronald, 2006 and Difco, 2009)** at about 45°C was aseptically poured in each sterilized glass Petri plate, then mixed well and left the pates for solidification. All plates were incubated at 30°C for a 3 days a digital incubator. The developed colonies were counted per each plate, after the incubation period. The mean values of colonies were calculated as follows: The bacterial count (colony forming unite, cfu) (cfu/g) = the mean number of three replicates of the same dilution x reciprocal of the dilution which used **(Anon, 1992)**. The most probable number (MPN) technique **(Anon, 1992)** was used for counting coliforms and *Clostridium*. Three decimal dilutions of each sample in the last three replicates were used. 1 ml of each suitable dilution of samples were added to test tube containing MacconKey broth medium or cocked meat medium, then incubated at 37°C for a 24h. The positive tubes were recorded. The most probable number of microbes per gram of sample was calculated from standard Tables **(Sutton, 2010)**. Moreover, aflatoxin was determined by thin layer plates of Silica gel method **(AOAC, 2000).**

Biochemical activities of microbial strains (proteolysis, lipolysis, and lactose assimilation)

Plates of PDA medium containing casein or oil were inoculated with a mixed culture isolated from hard cheese. After 2 days of incubation at 30°C, the plates were flooded with hydrochloric acid (10%) or copper sulfate (10%), respectively. The results were recorded by measuring the diameter of growth and clear zone **(El-Fadaly *et al.*, 2015a).** Nutrient broth medium containing 5 g of lactose was distributed in test tubes; each tube contained bromothymol blue and Durham's tubes. Sterilized tubes containing different lactose was inoculated with one loop of mixed culture mentioned above. After 24h of incubation at 30°C, the production of acid was recognized by the change in color from blue to yellow and the production of gas noted in Durham's tubes **(Difco, 2009).**

Chemical analysis:

Chemical analysis of cheese samples for fat, moisture, salt, lactose, protein content and pH according to **AOAC (2000).**

Sensory evaluation

Sensory evaluation was done according to **Jo et al. (2018).**

RESULTS AND DISCUSSION

Microbiological evaluation of imported hard cheese samples

Table (1) shows the microbiological evaluation of hard cheese. The total bacterial count reached to it maximum value in Roquefort cheese (3105 cfu/g) and the lowest value were 585 in Cheddar cheese. Similar results were obtained by **Ordiales *et al.*, 2013**. Edam cheese was the highest sample in fungal count (15000 cfu/g) while Gouda and Swiss cheese had not any fungi in the tested samples. Similar results were obtained by **Garnier *et al.*, (2017)**. *Staphylococcus*, *Salmonella*, *Shigella* and *Clostridium* did not achieve any count in all samples. Coliforms were present in all samples except Roquefort cheese. Moreover, aflatoxins did not present in all cheese samples. Similar results were obtained by **Hamad *et al*. (2022).**

Table 1: Microbiological evaluation of imported hard cheese samples

Samples	Microbial count (cfu/g)					
	Bacteria	Fungi	*Staphylococcus*	*Salmonella* and *Shigella*	coliforms	*Clostridium*
Roquefort	3105	125	-	-	-	-
Gouda	925	-	-	-	+	-
Edam	1335	15000	-	-	+	-
Cheddar	585	125	-	-	+	-
Lugriri	2520	-	-	-	+	-

Efficiency of the microflora of hard cheese for proteolysis, lipolysis, and lactose assimilation

Table (2) shows the efficiency of the microflora of hard cheese for proteolysis, lipolysis, and lactose assimilation. The microflora of all cheeses hydrolyzed protein except the microflora of Lugriri cheese. The lipid hydrolysis was done only by the microflora of Lugriri cheese. All microorganisms

of all cheeses assimilated lactose and produced acid and gas except the microbes of Requefort cheese.

Table 2: Efficiency of the microflora of hard cheese for proteolysis, lipolysis, and lactose assimilation

Mixed culture	Biochemical tests			
	Protein hydrolysis	Fat hydrolysis	Lactose assimilation	
			Acid	Gas
Roquefort	+	-	-	-
Gouda	+	-	+	+
Edam	+	-	+	+
Cheddar	+	-	+	+
Lugriri	-	+	+	+

On contrast, the finding of **El-Fadaly *et al.* (2015b)** stated that, all tested fungal strains which isolated from Ras cheese during repining period, showed positive results for casein hydrolysis and the presence of casein in the cultural medium caused a strong growth. Also, all strains gave positive results for lipolysis except *Aspergillus nidulans*. The chemical composition of Ras cheese during storage confirmed the fungal enzyme activities, where the fat percentage value increased after salting and during ripening period. The findings which reported by **Kure *et al.* (2001)** could explain the formation of gas where *G. candidum* is able to grow in environments with high levels of CO_2. Similar results were obtained by **Kure and Skaar (2000)** who reported that, *P. roqueforti* is capable of growth in an atmosphere with high levels of carbon dioxide, and the growth was unaffected, or slightly stimulated, by high levels of CO_2, especially when levels of O_2 were low. This species is also resistant to weak acid preservatives. This may explain why *P. roqueforti* var. *roqueforti* is the dominant species. Most of lactose in milk is lost in the whey as lactose or lactate during cheese manufacture. However, low levels of lactose remain in the curd at the end of manufacture. Residual lactose is metabolized quickly to lactate during the early stages of ripening at a rate largely determined by temperature and the salt-in-moisture (S/M) levels of the curd **(McSweeney and Sousa, 2000 and McSweeney, 2004).** The findings of **El-Fadaly *et al.* (2015a and b)** of 13 fungal strains isolated from Ras cheese during repining period, had negative effect in lactose assimilation except *A. nidulans* which produced acid without gas after 24 h and produced a soluble red pigment after 10 days of incubation at 25˚C. On the other hand, these organic acids have a good role to prevent the growth of harmful fungi and secretion of aflatoxins. The effect of organic acids as antifungal agents on the growth of some fungi such as *A. flavus* and *Rhizopus nigricans* which isolated from Ras cheese during repining period **(El-Fadaly *et al.*, 2015b)**. **Hassan *et al.* (2012)** found that, acetic acid showed the highest inhibition effect on *A. flavus* growth while tartaric acid and citric acid gave the lowest inhibition effect. Formic, acetic, and propionic acids had the highest inhibition effect on *A. flavus* growth. Also, these organic acids reduced aflatoxin secretion specially for *Rhizopus nigricans* in the presence of formic acid.

Chemical analysis:

Table (3) shows the chemical composition of hard cheese. The highest value of fat was 34.98% in Lugriri cheese and the lowest was 21.22% in Gouda cheese. Moisture fluctuated between 35.89 and 52.85% in Lugriri and Gouda cheese, respectively. Salt was ranged to 1.42 and 3.56% in Lugriri and Roquefort cheese, respectively. Maximum lactose was 2.61% while minimum was 1.08 in Lugriri and Edam cheese, respectively. Protein values were 21.01, 21.75, 22.86, 22.98 and 28.95 in Roquefort, Gouda, Edam, Cheddar and Lugriri cheese, respectively.

Table 3: Chemical composition of imported hard cheese samples

Samples	Chemical compassion (%)					
	Fat	Moisture	Salt	Lactose	Protein	pH
Roquefort	28.04	47.65	3.56	2.22	20.01	5.90
Gouda	21.22	52.85	3.10	1.48	21.75	4.90
Edam	22.30	50.80	2.95	1.08	22.86	4.89
Cheddar	30.86	40.17	1.52	2.54	22.98	4.91
Lugriri	34.98	35.87	1.42	2.61	28.95	5.77

Sensory evaluation

Table (4) shows that, the sensory evaluation of hard cheese. Color fluctuated between 4.61 and 5.00 in Roquefort and Gouda cheese, respectively. The highest value of appearance was 10 in Gouda, Edam and Lugriri cheese and the lowest was 9.67 in Roquefort cheese. Texture was ranged to 36.00 and 39.92 in Roquefort and Lugriri cheese, respectively. Maximum Flavor was 44.81 while minimum was 32.67 in Swiss and Cheddar cheese, respectively. Generally, total sensory evaluation was 86.05, 86.66, 94.18, 86.83 and 99.73 in Roquefort, Gouda, Edam, Cheddar and Lugriri cheese, respectively. Similar results of sensory evaluation were obtained by **Jo et al. (2018).**

Table 4: Sensory evaluation of imported hard cheese samples

	Color (5)	Appearance (10)	Texture (40)	Flavor (45)	Total (100)
Roquefort	4.61	9.67	36.00	35.77	86.05
Gouda	5.00	10.00	36.66	35.00	86.66
Edam	4.85	10.00	39.16	40.17	94.18
Cheddar	4.83	9.83	39.5	32.67	86.83
Lugriri	5.00	10.00	39.92	44.81	99.73

In this study, we found that the two types of cheese with the highest degree of color were Gouda, Lugriri being 5.0% and the lowest was Roquefort being 4.61%, rspectively. The highest of appearance was in the three types of cheese Gouda, Edam and Lugriri cheese which was 10% and the lowest value was in Roquefort cheese (9.67%). The highest value of texture was in Lugriri cheese (39.92%) and the lowest value was in Roquefort cheese (36.00%). The flavor was higher valuye in Lugriri (44.81%) and lower value was in Cheddar (32.67%). Generally, total sensory evaluation was in highest value in Lugriri (99.73%) and lowest was in

Roquefort cheese (86.05%). Similar results were obtained by **Jo *et al*., (2018).**

CONCLUSION

After various microbiological, chemical and sensory studies, the study proved that the types of cheese under study were acceptable, with respect to the Egyptian standard specifications or with regard to the sensory evaluation through which the consumer prefers types of cheese.

FUNDING:

This research was self-funded.

CONFLICT OF INTEREST:

The authors declare that they have no conflict of interest.

AUTHORS CONTRIBUTION

Hamad, M. H and El-Kadi, S. M. developed research proposal, shared manuscript preparation and revision.

shalaby, Hana. handled the experiment and measurements and shared manuscript preparation.

REFERENCES

Abd Elmontaleb, H., Galal, E., Abdelmageed, D., & Hamdy, S. (2020). Biochemical and microbiological properties of Edam cheese with black cumin oil. Egyptian Journal of Food Science, 0(0), 0–0. https://doi.org/10.21608/ejfs.2020.26081.1046

Anon 1992. Compendium of Methods for the Microbiological Examination of Foods. The 3rd Ed. American Public Health Association. Washington. D.C., USA.

AOAC 2000. Association of Official Analytical Chemists. Methods of Analytical Chemists. USA.

Can, F.O.; A. Demirci; V.M. Puri and H. Gourama 2014. Decontamination of Hard Cheeses by Pulsed UV-light. ASABE Annual International Meeting. https://doi.org/10.13031/aim.20141894309

Difco and BBL Manual 2009. Manual of Microbiological Culture Media Second Edition. Becton, Dickinson and Company parks, Maryland 21152. U.S A.

El-Fadaly, H.; S.M. El-Kadi, M.N. Hamad and A. Habib 2015b. Role of Fungal Enzymes in the Biochemistry of Egyptian Ras Cheese during Ripening Period. *Open Access Library Journal*, 02, 1-13. doi: 10.4236/oalib.1101819

El-Fadaly, H.; S.M. El-Kadi; M.N. Hamad and A. Habib 2015a. Isolation and identification of Egyptian Ras cheese contaminating fungi during ripening period. Journal of Microbiology Research. 5(1): 1-10.

Garnier L, Valence F, Mounier J 2017. Diversity and control of spoilage fungi in dairy products: an update. Microorganisms; 5: 1–33.

Gripon, J.C. 1993. Mould- ripened cheeses. In; Cheese chemistry, physics and microbiology. Vol. II Major Cheese Groups. Edited by Fox, P.F., Elsevier Science Publisher Ltd, Cambridge, England.

Hamad, M.; H., El-Kadi, S. and Gamal, G. 2022. Hazard Analysis and Critical Control Points (HACCP) in pasteurization department for a Dairy Factory in Damietta Governorate. Damietta Journal of Agricultural Sciences (DJAS). 1:(1).1-8. http://publication.du.edu.eg/journal/ojs302design/index.php/agr/article/view/2643/1015

Hassan, R.A.; S.M. El-Kadi and I.S. Mostafa 2012. Effect of some organic acids on fungal growth and their toxins. Journal of Agricultural Chemistry and Biotechnology, 3(9), pp. 391-397. https://doi.org/10.21608/JACB.2012.55011

Jack, F.R. and Paterson, A. 1992. Texture of hard cheeses. Trends in Food Science and amp; Technology, 3, 160–164. https://doi.org/10.1016/0924-2244(92)90178-y.

Jo, Y., Benoist, D. M., Ameerally, A., & Drake, M. A. 2018. Sensory and chemical properties of Gouda cheese. Journal of Dairy Science, 101(3), 1967–1989. https://doi.org/10.3168/jds.2017-13637

Kure, C. F. and I. Skaar 2000. Mould growth on the Norwegian semi-hard cheeses Norvegia and Jarlsberg. international Journal of Food Microbiology. 62: 133–137.

Kure, C. F.; Y. Wasteson; J. Brendehaug and I. Skaar 2001. Mould contaminants on Jarlsberg and Norvegia cheese blocks from four factories. International Journal of Food Microbiology. 70: 21–27.

McSweeney, P L. H. 2004. Biochemistry of cheese ripening. International Journal of Dairy Technology. 57(2/3): 124-144.

McSweeney, P L. H. and M. J. Sousa 2000. Biochemical pathways for the production of flavour compounds in cheeses during ripening: A review. Lait. 80: 293–324.

Ordiales, E., Benito, M. J., Martín, A., Casquete, R., Serradilla, M. J., & Córdoba, M. G. 2013. Bacterial communities of the traditional raw Ewe's milk cheese "Torta delCasar" made without the addition of a starter. Food Control, 33, 448–454. https://doi.org/10.1016/j.foodcont.2013.03.027.

Ronald, M. A. 2006. Handbook of microbiological media for the Examination of food. CRC Taylor and Francis Group Boca Raton London New York.

Sutton S. 2010. The Most Probable number method and its uses in enumeration, qualification, and validation. J. Validation Technology. PP. 35-38.

Ulpathakumbura, C. P., Ranadheera, C. S., Senavirathne, N. D., Jayawardene, L. P. I. N. P., Prasanna, P. H. P., & Vidanarachchi, J. K. 2016. Effect of biopreservatives on

microbial, physico-chemical and sensory properties of Cheddar cheese. Food Bioscience, 13, 21–25.

Weinrichter, B.; Rohm, H. and Jaros, D. 2000. Mechanical properties of unpressed semi-hard cheeses by uniaxial compression. Journal of Texture Studies, 31(2), 141–152. https://doi.org/10.1111/j.1745-4603.2000.tb01413.x.

Zerfiridis, G. K., Vafopoulou-Mastrogiannaki, A.,&Litopoulou-Tzanetaki, E. 1984. Changes During Ripening of Commercial Gruyère Cheese. Journal of Dairy Science, 67(7), 1397–1405.

التقييمات الكيميائية والميكروبيولوجية والحسية لبعض أنواع الأجبان الصلبة وشبه الصلبة المستوردة

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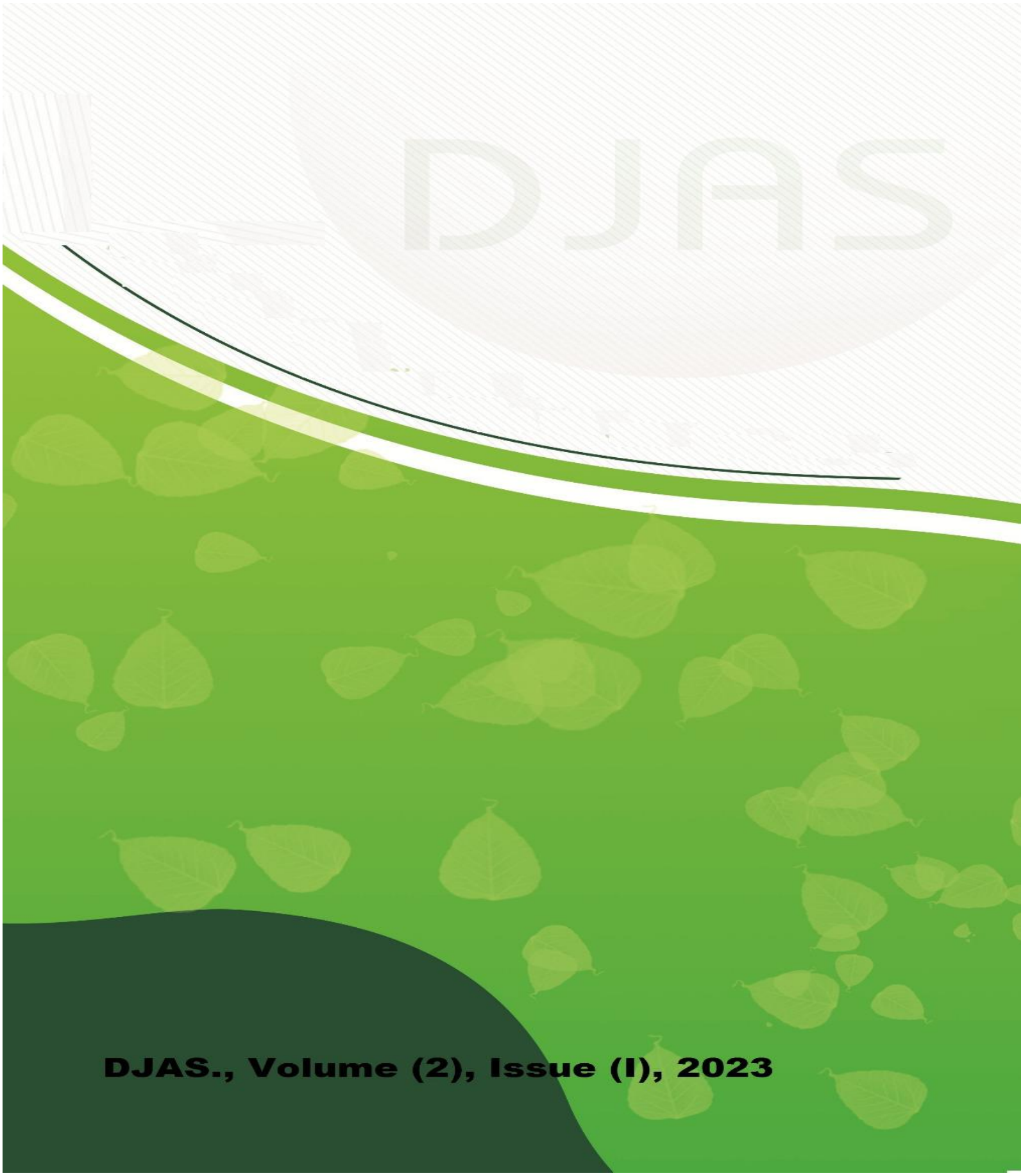
الملخص العربي

جمعت خمس عينات(ثلاث مكررات) مختلفة من الأجبان الصلبة وشبه الصلبة المستوردة (ريكفورت، جودا، إيدام، شيدر و غروييز) من مصادر مختلفة بمحافظة بورسعيد. أجريت عليها تقييمات ميكروبيولوجية وكيميائية وحسية. كانت أعلى قيمة لإجمالي عدد البكتيريا (٣١٠٥ وحده مكونه للمستعمرة/جرام)، وأقل قيمة كانت (٥٨٥ وحده مكونه للمستعمره/جرام) في جبن غروييز (لوجريري) وجبن الشيدر، على التوالي. بينما كانت أعلى قيمة للعد الكلي للفطريات (١٥٠٠٠ وحده مكونه للمستعمرة/ جرام) في جبن الإيدام وأقل قيمة كانت (١٢٥ وحده مكونه للمستعمرة/ جرام) في جبن الريكفور وجبن الشيدر. وجدت بكتيريا القولون في جميع العينات ما عدا جبن الريكفورد. كما لم يتم العثور على السالمونيلا والشيجلا في جميع العينات. جميع عينات الجبن لا تحتوي على المكورات العنقودية أو الكلوستردييوم. فيما يتعلق بالتركيب الكيميائي، تراوح الأس الهيدروجيني pH للجبن من (٥.٩٠ إلى ٤.٨٩) للجبن الريكفور والإيدام، على التوالي. أقل نسبة ملح (١.٥٢ و١.٤٢) في جبن الشيدر الأحمر. تتراوح نسبة الدهون من (٣٤.٩٨٪ إلى ٢١.٢٢٪) في جبن لوجريري. أعلى قيمة للرطوبة سجلت ٥٢.٨٥٪ في جبنة الجودة وأقل قيمة ٣٥.٨٧٪ في جبن لوجريري. كانت أعلى قيمة للبروتين في جبن لوجريري (٢٨.٩٥٪)، وأقل قيمة كانت في جبن الريكفورد (٢٠.٠١٪). توجد أعلى نسبة من اللاكتوز في جبن لوجريري، وأقل نسبة من اللاكتوز توجد في جبن إيدام بنسبة (٢.٦١٪ و١.٠٨٪) على التوالي.

الكلمات المفتاحية

جبن صلب وشبه صلب مستورد، تخمير اللاكتوز، تحلل الدهون، تحلل البروتين، التركيب الكيميائي، التقييمات الحسية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