



Research article

Assessment of consumer demographics and food safety risks associated with ready-to-eat (RTE) homemade foods purchased online in the UAE

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ABSTRACT

In the UAE, female entrepreneurs, termed “Tajrat”, sell a variety of homemade food products over online social media (OSM) platforms. Some of these food products are prepared and sold outside regulatory channels, with serious public health consequences. The study aimed to identify consumer demographics associated with purchasing of RTE, homemade food sold over in OSM platforms in the UAE and to assess the food quality by evaluating microbiological quality and fat percentage in RTE foods. A representative survey of the population of the UAE (n = 1303) was conducted, covering consumer demographics, frequency of purchase, and respondents’ perception towards safety and nutritional value. 66 % of respondents were Emiratis, fifty percent of whom purchased RTE foods online. Moreover, 61 % of participants purchased from “Tajrat” via OSM as opposed to other sources. Convenience (47 %) and taste (41 %) were the main drivers for purchasing RTE homemade foods. Although 76 % of respondents have at least one member of their family considered vulnerable, the safety levels, quality, and nutritional value of such products did not carry the same significance. Microbiological analysis of 35 food samples purchased online from “Tajrat” was conducted. *Listeria* spp. was isolated from 22 % of the samples, 43 % showed positive *Staphylococcus aureus*, and 31 % of the samples had coliform bacteria. Total Fat Content of RTE homemade food samples ranged between 2.6 and 30 g/100 g which is considered high and can cause serious health issues if consumed frequently. Recommendations from this study will help policy makers and regulators in the UAE to develop and implement education strategies targeting homemade food handlers.

1. Introduction

Food handling and safety is a critical ongoing global issue, that keep reigniting from the never-ending cases of foodborne illnesses caused by improper agricultural, manufacturing, and handling practices [1–3]. According to the World Health Organization (WHO) foodborne illnesses are diseases, either infectious or toxic, caused by pathogens that enter the digestive system through the ingestion of

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food [4]. Foodborne illnesses negatively affect the productivity, wellbeing, and health care expenditure of the aggrieved person. Moreover, in some cases, they have the potential to create chronic, lifelong health problems such as kidney disease, arthritis, and digestive disorders [5–7]. Most reported foodborne illnesses cases are due to inadequate cooking, cooling and storage of foods, cross-contamination of raw and cooked foods, and poor personal hygiene such as hand washing [7–10]. According to Tajkarimi, Ibrahim, & Fraser [11], 50–85 % of foodborne outbreaks are associated with homemade food. The main pathogens that are commonly found in ready-to-eat (RTE) foods are *Staphylococcus aureus*, *Salmonella*, *Escherichia coli*, *Bacillus cereus*, *Klebsiella*, *Shigella*, and *Pseudomonas* species [12]. All the mentioned pathogens are known to be present in RTE foods due to poor personal hygiene and improper practices such as cross contamination, improper cooking temperature and storage conditions. Therefore, proper food handling, preparation, and distribution is vital in any food service establishments and at home to reduce foodborne illness [13,14].

The 2010 Dietary Guidelines for Americans contain a priority area emphasizing the need for improved food safety habits. The US Centre for Disease Control's Healthy People 2030 program has an objective for increasing consumer adherence to important food safety practices [15]. According to several previous studies, poor and unbalanced food diets have also been found to be responsible for a substantial proportion of mortality and disease burden in many world regions [16,17]. Among harmful dietary factors, high intake of sodium was found to be responsible for the highest number of deaths due to cardiometabolic diseases (CMD) in the Middle East and North Africa [18,19]. According to Worldometer (2023), the total population of UAE is around 10.25 million, with approximately 98.9 % active on social media. The increased popularity of social media platforms has opened opportunities for new business models for electronic commerce (e-commerce), or social commerce (s-commerce). S-commerce involves the use of social media that supports social interaction and user contribution to assist in online buying and selling of products and services [20]. In s-commerce, consumers make decisions based on not only information from the sellers, but also from other consumers [21]. In UAE e-commerce is increasing with many UAE locals and residents having started to sell and buy on social media [22]. These networks sell a variety of products such as accessories, services, homemade clothes, beauty products, as well as foods. "Tajrat" is the word used by the locals to describe the female traders. The number of Emirati women who are establishing these types of businesses dramatically increased in recent years [23]. Emirati women rely heavily on social media networks to market and advertise their merchandise and businesses as they can reach consumers easily and effectively. Considering its cultural importance, many of the s-commerce businesses in the UAE revolve around homemade food. Many of these businesses promoting homemade foods operate outside the official channels of regulatory food control systems and are not monitored, inspected, or audited. It is unlikely that homemade food handlers are trained in good manufacturing practices (GMP) of food, including good sanitation measures and proper food handling, preparation, storage, and delivery procedures. This, coupled with the lack of adherence to recommended nutritional allowances could pose a significant public health issue for UAE residents consuming RTE homemade foods purchased through OSM. The Dubai Municipality (DM) has already introduced an electronic trader license, but this is still not fully in action according to sources from Abu Dhabi Department of Economic Development (DED) [24]. Previous study done in India and Malaysia has evaluated the factors affecting the purchase decision of RTE foods in that region and the findings indicated that the price, convenience, taste, and nutrition were the main factors [25]. Another study done in Switzerland that monitored the food choice behavior of 851 adults over a one-year period has highlighted that the customers' behavior and awareness were the main factors that affected their choices when purchasing food products and showed the potential of using such findings with implications or health prevention programs, environmental protection actions, marketing, and strategic alignment of food products [26].

Evaluation of the food risks during this transitional period before the newly imposed policy of certification of on-line food traders will prove instrumental to monitoring their effectiveness during implementation and after. Therefore, the main objectives of this study were to identify the consumer demographics and purchasing behavior related to purchasing ready-to-eat (RTE), homemade foods sold over OSM platforms in the UAE and to access the safety of RTE, homemade foods in terms of microbiological quality and fat content. The findings of this current study will assist policy makers and regulators in the UAE to develop and implement education strategies targeting homemade food handlers.

2. Methodology

Primary data was collected through a survey, prepared in both English and Arabic to accommodate multilingual population of the UAE (Appendix 1). The survey was approved by Social Science Research Ethics Committee SScECR in UAEU (Appendix 2). Moreover, an audiovisual that explained in detail the purpose of the study and how to answer each question was added as a mandatory prerequisite step before starting the survey. The survey targeted approximately 1300 individuals from all seven Emirates and was conducted via online and face to face interviews.

The Survey included following sections:

- 1) Participants' sociodemographic characteristics like age, household size, education, health issues, and income.
- 2) Purchase behavior, frequency, social platforms used etc., types of foods purchased, frequency and value paid.
- 3) Participants' perception regarding food risks in these purchases.

After analysis of the survey data, 66 food samples representing 14 food types of common Arabic and Emirati dishes, including deserts were ordered on-line for microbiological and fat content analysis. Each food type was analyzed five times from different sources (Table S1). Orders were put online using 31 different tajrat's accounts covering all the seven UAE Emirates, the majority of purchases were from Al Ain (Fig. S1).

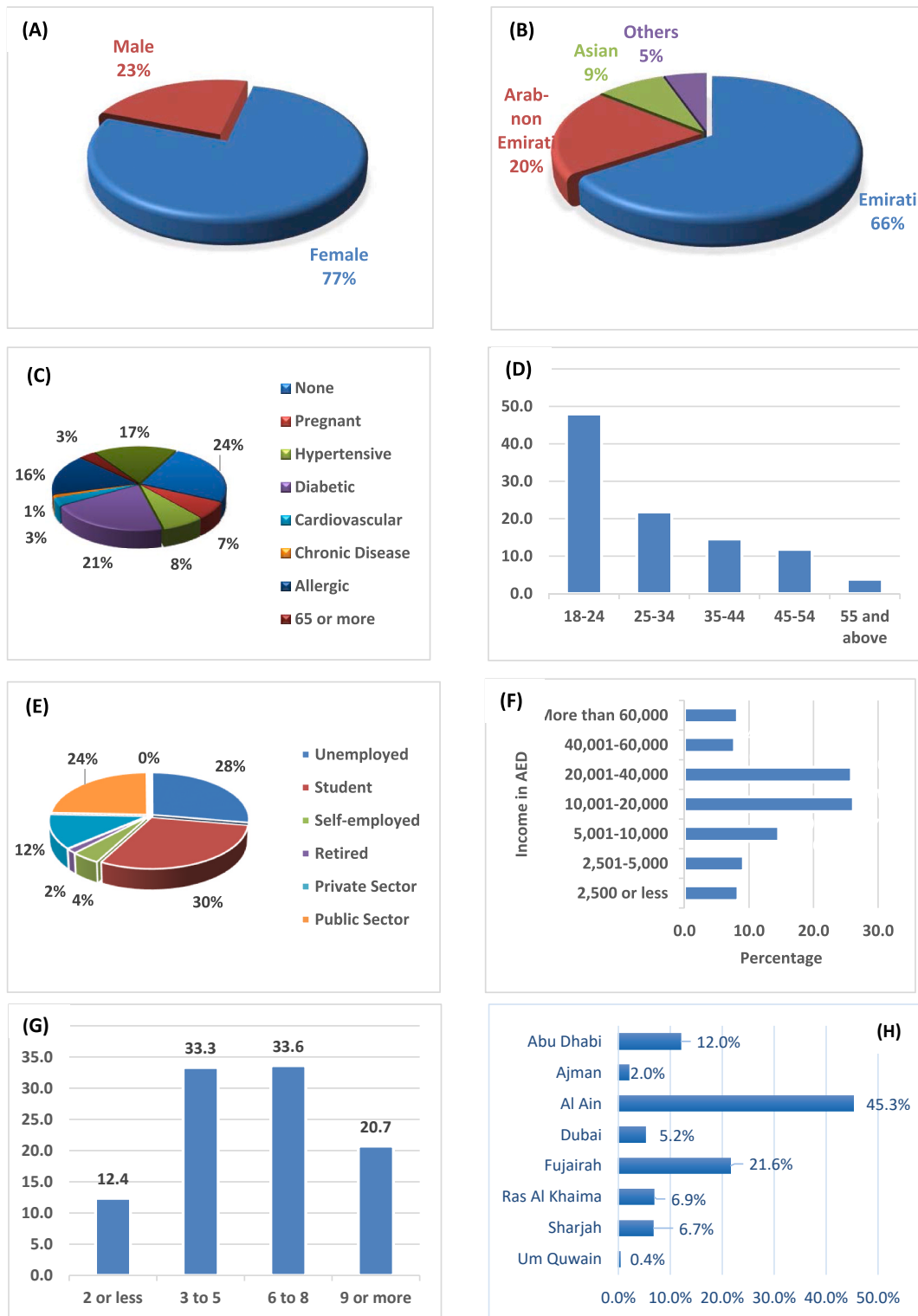


Fig. 1. A; Gender, B; Nationality, C; Sensitive groups, D; Age, E; Employment details, F; Monthly household income G; Family size, H; Geographic distribution of respondents.

2.1. Microbiological evaluation of homemade ready-to-eat foods

The 66 food samples purchased from female traders “Tajrat” using many social media platforms were delivered directly to the UAE University campus and were analyzed on the same day of delivery. The food samples covered all 14 food types listed in Table S4. For sample preparation, 20 g of each food sample were taken aseptically then placed in a sterile plastic bags. 180 ml of sterile mixture containing NaCl (0.85 g/L), peptone (1 g/L), and Tween 80 (1 ml/L) was added to sample and the mixture was homogenized for 60 s using a Stomacher Lab-Blender. Different dilutions of the sample mixture were done using sterile peptone water (0.1 %) and inoculated 5 times in growth media using standard pour and spread plate technique to evaluate the microbial counts. The analyses were done using the following reference methods, TS ISO 21527-1/2 for mold and yeasts, ISO 4833–1:2013 for total aerobic plate count, TS EN ISO 9308-1 for coliform, TS EN ISO 6888-1/A1 for *staphylococcus aureus*, and TS EN ISO 11290-1 for *listeria monocytogenes*. The obtained results were presented in log of colony forming units (cfu) per gram of RTE homemade food sample.

2.2. Total fat content in ready-to-eat homemade foods

The fat content of RTE homemade foods was determined following the methods as described in AOAC Official Method 996.06 [27]. Food samples were extracted with light petroleum ether with the solvent removed by distillation using Soxhlet extraction equipment. The residue was dried at 103 °C and the fat content was determined gravimetrically. The determined fat content was expressed as grams of fat per 100 g of RTE homemade food sample.

2.3. Statistical analysis

For the analysis of data, SPSS software (version 24, SPSS Inc., Chicago, IL, USA) was used. Descriptive analysis and graphical representation of collected responses (1,303) focused on the heterogeneity of respondents with respect to nationality, rate of purchasing homemade ready to eat foods, reasons for buying such products, income, etc. Finally, Pearson correlation analysis was used to correlate several factors such as gender, age, education level, income, and family size with the participants’ level of hygiene consideration before purchasing RTE homemade foods online and reasons for not buying such products.

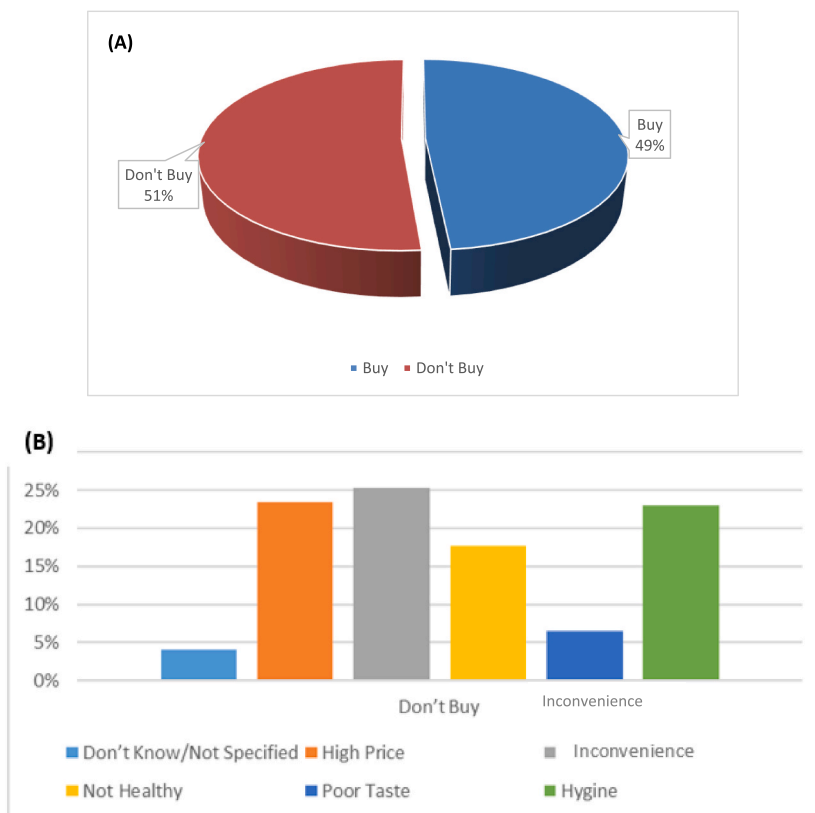


Fig. 2. A) Tendency to purchase RTE homemade foods online; B) Reasons for refraining from buying RTE homemade foods.

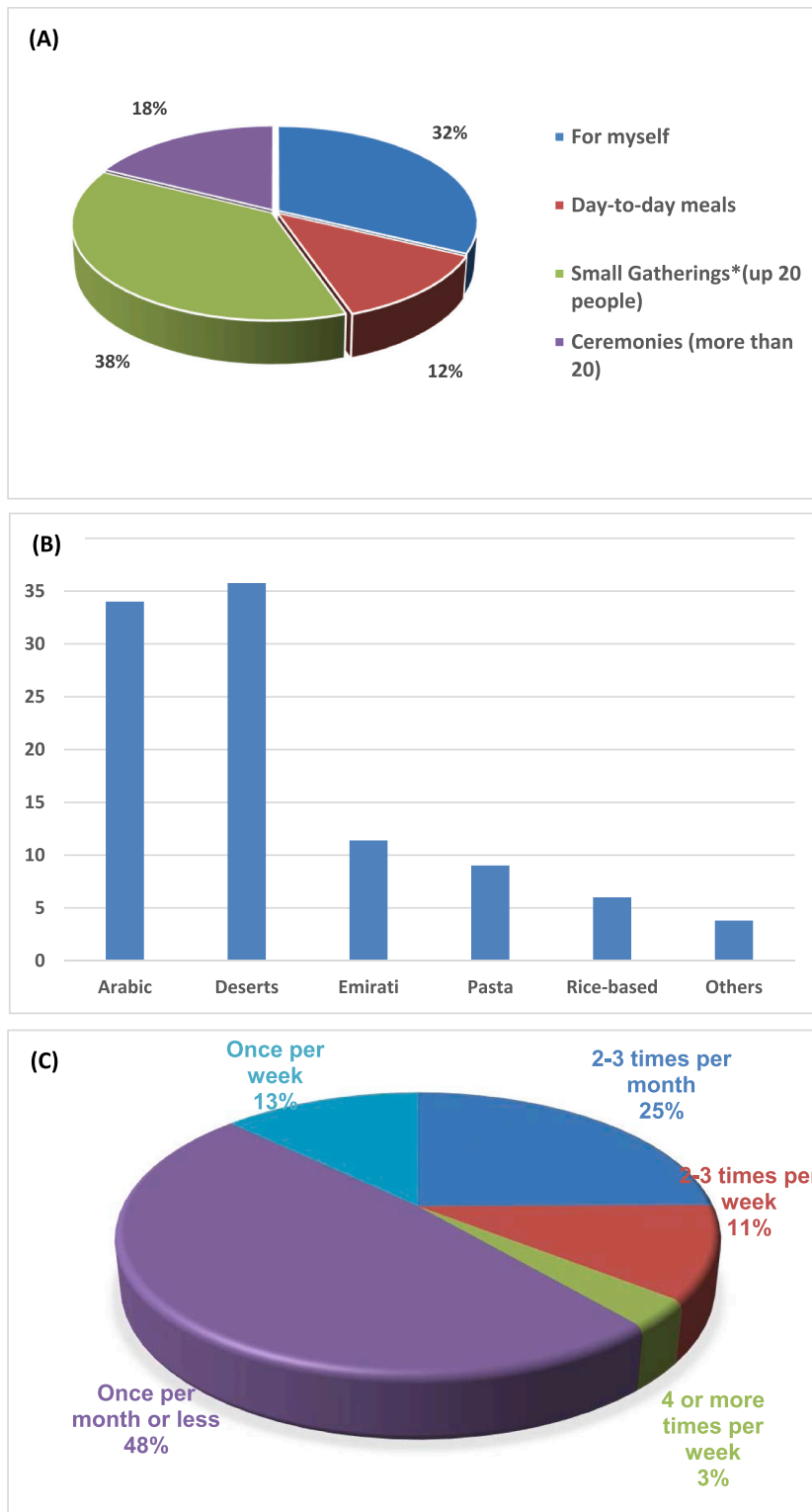


Fig. 3. A) Occasions for purchasing ready to eat homemade foods; B) Types of foods most frequently purchased from Tajrat; C) Frequency of purchases of RTE foods.

3. Results and discussion

3.1. Demographic characteristics of the respondents

The demographic characteristics of the respondents are shown in Fig. 1. According to the obtained data, most respondents were female (77 %) (Fig. 1A), Emirati (66 %) (Fig. 1B), and between 18 and 24 years of age (Fig. 1D). Thirty percent of participants were students and 28 % were unemployed bachelor’s degree holders (Fig. 1E). The income of respondents seems to be differentiated significantly. While the income of 52 % of respondents falls between AED 10,000–40,000, 8 % has 2500 or less and 8 % has more than AED 60,000 (Fig. 1H). Further, 76 % of respondents have somebody in their family who is considered a member of a sensitive group, which included people with diabetes, allergy to some food, pregnant, under five or above 65 (Fig. 1C). The number of family members in the household ranged from 2 to 9, with the majority of households between 3 and 8 (70 %) (Fig. 1G). Most respondents were from Alain (45 %), with a representation from all the other Emirates, with Fujairah at 22 %, and Abu Dhabi at 12 % (Fig. 1H).

3.2. Purchasing behavior of respondents

The analysis of the data provided an overview regarding the behavior of respondents towards purchasing ready-to eat home-made foods from the traders. As indicated in Fig. 2A, the findings showed that on-line buying of RTE homemade foods from female traders, “Tajrat”, is prevalent amongst 49 % of the surveyed population, especially households with higher income (63.55 %) (Fig. S4B). The magnitude of purchasing RTE foods significantly depends - on gender since men and women have different motives, perspectives, rationales, and considerations when it comes to home-made RTE foods from the Tajrat. This significant majority among female buyers

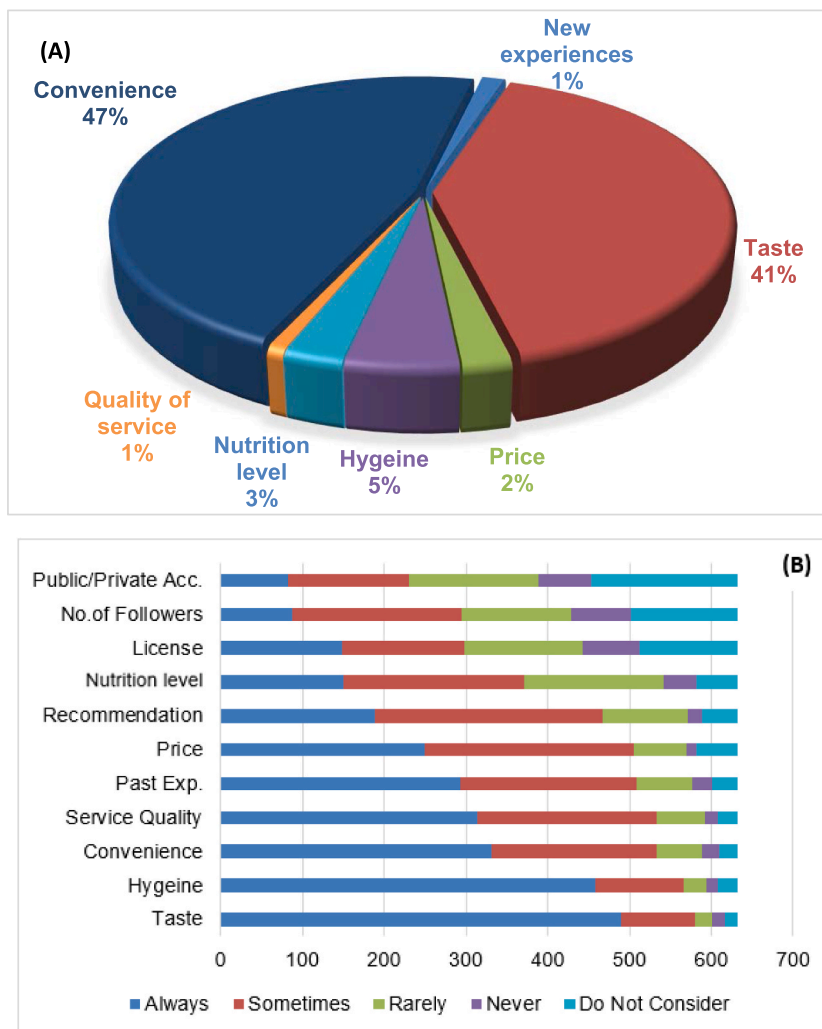


Fig. 4. A) Reasons behind purchases of RTE homemade foods on-line; B) Factors influencing the participants' decision to choose between different traders.

suggests a notable gender-dependent purchasing behavior, potentially influenced by cultural factors that may deter males from engaging in this particular consumption pattern. Among the respondents that do not buy ready-to eat home-made foods from the traders, the main factors that influenced their decision were Inconvenience, poor hygiene, and high price of such foods (Fig. 2B).

Around half the respondents (56 %) seemed to buy on-line ready-to-eat homemade foods to be used in small gatherings as shown in Fig. 3A. Individuals purchasing for themselves also make up a significant proportion of the purchases (up to 32 %). According to the results indicated in Fig. S2A, “Tajrat” was the most frequently used source to order food among the respondents (61 %) compared to the

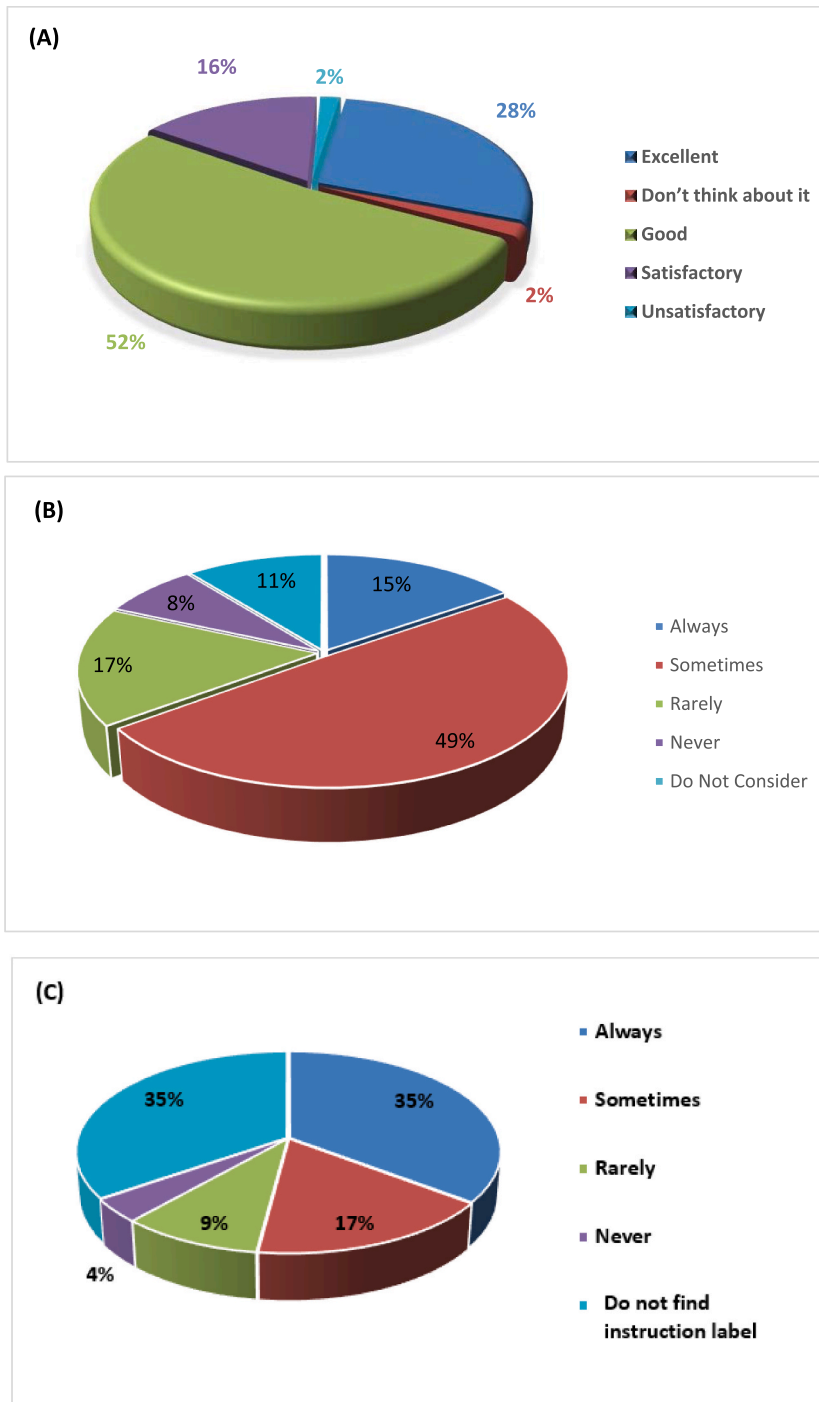


Fig. 5. A) Perception on RTE homemade foods hygiene; B) Concern about contamination during delivery of RTE homemade foods; C) Adherence to food label shelf-life instructions by the respondents.

application “Talabat” (38 %). Snapchat was found to be the most popular social media platform amongst respondents, with 77 % of respondents using Snapchat to order their ready-to eat home-made foods from the Tajrat. Instagram and WhatsApp were used equally commonly, with Facebook the least frequently used platform (Fig. S2B). The most popular types of food ordered and bought from Tajrat were found to be desserts (36 %), Arabic dishes (Arabic) (34 %), and local Emirati dishes (Emirati) (11 %) (Fig. 3B). When analyzing the frequency of purchases (Fig. 3C) and the value of last meal purchased (Fig. S3) it was found that 56 % spent less than 299 AED for purchasing RTE food. 27 % of respondents purchased foods from Tajrat 1–4 times or more per week, 25 % bought 2–3 times per month, while 48 % did so once per month (Fig. 3C).

3.3. Motivation behind purchasing RTE homemade foods

From the obtained responses, convenience (47 %) and taste (41 %) were the main reasons that encouraged the customers to purchase RTE homemade foods. Price, hygiene, and quality were not considered as the main drivers for purchasing RTE homemade foods (Fig. 4A). The taste (77 %), hygiene (72 %), convenience (52 %), and service quality (49 %) were the main factors that made the participants choose one trader over another selling the same types of food (Fig. 4B). Whereas 33 % of all respondents never considered the nutritional values of the RTE foods when choosing between traders.

3.4. Respondents' perception towards RTE homemade foods purchased on-line from tajrat

To gauge the respondents' perception towards RTE foods, they were asked to rate the hygiene, confidence in nutritional value, and concern about contamination of the food during delivery. Eighty percent of consumers perceive RTE homemade as having excellent to good hygiene (Fig. 5A). Fifty percent of consumers have low-to-no confidence in the RTE homemade foods' nutritional value, while 23 % do not think about it, and only 27 % are highly confident of the nutritional value (Fig. S4). Finally, the obtained responses showed that only 15 % of the respondents are always concerned about the possibility of contamination during delivery, 49 % are sometimes concerned and 36 % have no concern or rarely think about it (Fig. 5B). The respondents were also asked if they followed shelf-life instructions found on the label of the RTE homemade foods, if applicable and only 35 % of respondents always followed the shelf-life instructions (Fig. 5C). While 35 % of respondents claimed that they did not find food labels on their purchases.

3.5. Correlation between variables and purchasing of RTE homemade foods

To ascertain the relationship between the different variables and the frequency of purchase, correlation coefficients were calculated to identify the degree of association. Age and level of education were negatively correlated with frequency of purchasing (Table 1), with younger and less educated individuals purchasing more frequently. 60 % of respondents aged in the range 18–24 tend to purchase RTE homemade foods, with older aged groups less likely to purchase (21 % for ages 45 and above) (Fig. S5A). The behavior of purchasing RTE homemade foods online is more widespread among households with higher income, as indicated in Fig. S5B, where 63 % of the higher income households purchase RTE homemade foods from Tajrat, as compared to 40 % of lower income households. Respondents' perception about the hygiene of their foods purchased online from Tajrat has no correlation with age, education, and family size. However, perception of hygiene was associated with income ($r = 0.092$, $P < 0.05$), while gender has a negative correlation but of no significance (Table 2).

3.6. Microbiological analysis of RTE homemade foods purchased online from tajrat

A total of 66 food samples were purchased from female traders “Tajrat” through various social media platforms. The food samples which were ordered from all seven UAE Emirates were delivered directly to the UAE University campus and were analyzed on the same day of their delivery. The 66 food samples contained five samples from each of 12 food types (Table S1). For Balaleet (B) and Cheese cake (CH), only three samples were ordered from each due to unavailability of the product at the time of analysis. 31 % of the samples tested showed yeast and mold growth ranging from 2.47 to 6.42 log cfu/g of sample and 57 % of the food samples had total aerobic bacteria in the range of 2.6–8.89 log cfu/g of sample (Fig. 6). Samples from 71 % of the accounts showed growth of yeast and molds and aerobic plate counts. Contamination of food samples with pathogenic microorganisms was observed in 77 % of the accounts, from all Emirates. *S. aureus* was found in 43 % of the 66 food samples analyzed ranging from 2.45 to 8.65 log cfu/g of sample (Fig. 7). Approximately 31 % of the 66 food samples were found to contain *Coliform* bacteria when isolated in VRBGA in the range of 2.54–8.47 log cfu/g of sample (Fig. 7). *Listeria monocytogenes* was found in approximately 22 % of all food samples analyzed, which is not a good indication since *Listeria monocytogenes* is zero tolerance pathogenic bacteria in RTE foods [28,29].

Table 1
Correlation coefficients of frequency of purchase with age and education level.

		Age	Education
Frequency	Pearson correlation	-.130*	-.135 ^a
	Sig. (2-tailed)	0.011	0.008
	N	387	387

^a Correlation is significant at the 0.01 level (2-tailed).

Table 2
Pearson correlation coefficients of hygiene and reasons for no purchases.

Variables	Hygiene consideration	Reason for no/limited purchase
Gender	-0.071	-.076 ^a
Age	0.059	-0.044
Education	0.021	-.098 ^a
Income	.092 ^b	-0.024
Family Size	0.021	0.043

^a Correlation is significant at the 0.01 level (2-tailed).

^b Correlation is significant at the 0.05 level (2-tailed).

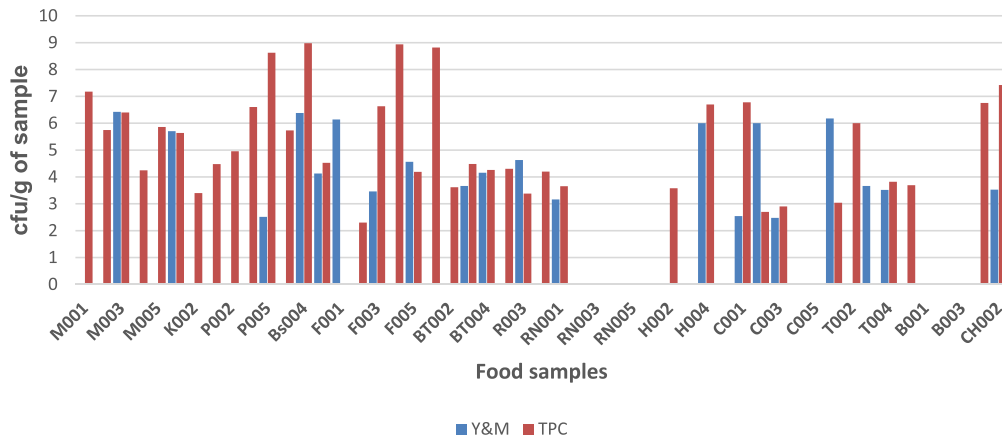


Fig. 6. Yeast, molds, and aerobic plate counts in RTE, homemade foods.

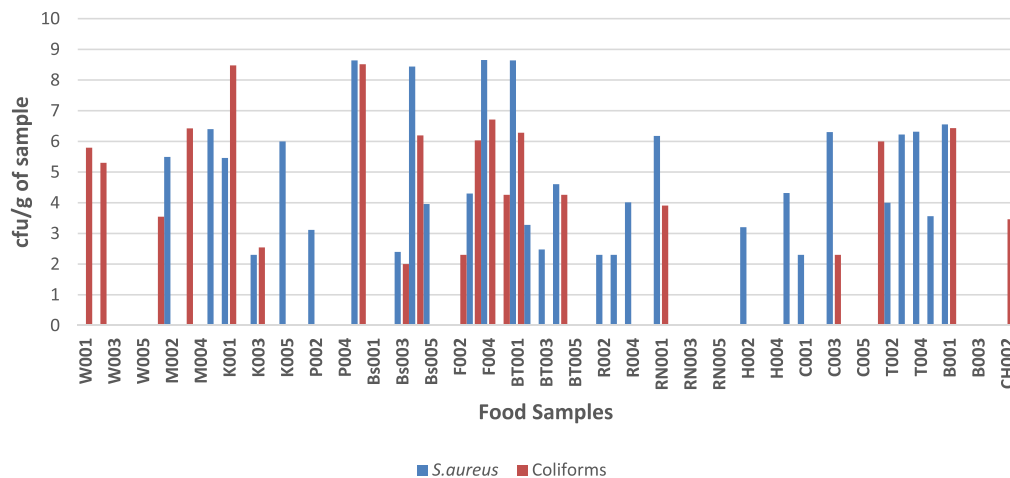


Fig. 7. *S. aureus* and Coliform Counts in RTE homemade food samples.

S. aureus, Coliforms and *Listeria monocytogenes* were prevalent in 12 out of the 14 food types with all the food types containing different levels of pathogenic bacteria. Multiple (2–5) food samples were purchased from 12 accounts. Thirty-four food samples purchased from six of these accounts contained contamination in 75 %–100 % of their samples; the rest had levels of contamination in 50–60 % of their samples (Table 3).

Table 3
Levels of contamination across food types.

Sample Types	% Contamination Pathogenic bacteria	log cfu/g
W1-5	40	5.3–5.79
M1-5	80	3.54–6.42
K1-5	80	2.54–8.48
P1-5	40	3.11–8.63
Bs1-5	60	2.39–8.43
F1-5	60	2.34–8.65
BT1-5	60	2.47–8.63
R1-5	80	2.3–4.0
RN1-5	40	Listeria only
H1-5	60	3.2–4.3
C1-5	40	2.3–6.3
T1-5	100	3.5–6.3
B1-3	NA	NA
CH1-3	33.3	NA

3.7. Total Fat Content of RTE homemade foods

The fat content determined in RTE homemade foods is presented in Table 4. There was considerable variation among the fat content of the different food types. Stuffed grape leaves samples (W1-5), Masakhan (M1-5), Koshari (K1-5) and Pasta (P1-5) showed lower fat content with values of 5.31, 8.47, 7.10, and 2.67 g/100 g, respectively when compared to the other food types. Some foods, mainly deserts, are prepared with butter and oil, and are expected to have a significantly higher amounts of fat such as Basboosa (Bs1-5), Cookies (C1-5), Truffles (T1-5), and cheesecake (CH 1–3) at 12.33, 29.61, 24.33, and 17.67 g/100 g, respectively.

4. Discussion

Correlation analysis was performed on the consumers demographics and purchasing behavior to show the influence of different independent variables on each other. The obtained data has shown that age and education level had a significant negative effect on the customers' decision and frequency of buying RTE foods with p-values of 0.011 and 0.008, respectively (Table 1). Therefore, the obtained data highlighted that the unmonitored RTE market heavily relies on or targets young customers with low awareness and health considerations. The monthly household income did have a significant negative effect when correlated with hygiene consideration when buying RTE foods online but had no clear indication of whether its increase or decrease will affect the participants' decision to purchase (Table 2). Moreover, the size of the family did not have a significant effect on the level of hygiene consideration by the participants when buying RTE homemade food online nor was it a main factor for not purchasing them. Another previous study evaluated the food safety measures knowledge, practices, and attitude of home-based online food businesses owners in Jordan during the COVID-19 pandemic via cross sectional survey and reported that 53.8 % of participants had low knowledge, improper practices, and negative attitudes toward proper food safety measures [30].

Standardizing the food sanitation operating procedures within each country and between countries is critical with several international agreements enforcing international standards [31]. Among these standards are the Codex Alimentarius commission (CAC), Hazard analysis and critical control point (HACCP), and good agriculture, manufacturing and handling practices which help reduce or minimize the contamination of food products at any step in the food chain [32]. However, unmonitored, and unlicensed food businesses such as Tajrat selling RTE foods online are falling through the gaps of the UAE monitoring systems and increases risk of FBD

Table 4
Total fat content of RTE homemade foods.

Sample type	Fat content g/100 g
W1-5	5.31 ± 0.83
M1-5	8.47 ± 0.67
K1-5	7.10 ± 1.03
P1-5	2.67 ± 0.35
Bs1-5	12.33 ± 1.24
F1-5	16.33 ± 1.51
BT1-5	12.09 ± 1.39
R1-5	7.67 ± 0.75
RN1-5	23.52 ± 1.46
H1-5	4.67 ± 0.48
C1-5	29.61 ± 1.74
T1-5	24.33 ± 1.29
CH1-3	17.67 ± 0.86

Data expressed as g of fat per 100 g of RTE homemade foods on a fresh weight basis.

outbreak which could lead to significant health and economic burden. According to previous studies around 70 % of all food outbreaks are associated with homemade foods [11,33]. In Europe, 41.3 % of the total number of FBD outbreaks were associated with foods prepared at home [34]. However, FBD outbreaks were linked to commercial establishments more than household in countries such as United states, India, Australia, New Zealand, and Denmark [31]. This study is the first to evaluate the safety levels in terms of the count of pathogenic bacteria, yeast, and molds present in RTE homemade foods ordered via OSM platforms from Tajrat in the UAE. Moreover, the study investigated the UAE resident's purchasing behavior. For the microbial analysis, 31 % of the samples showed yeast and mold growth ranging from 2.47 to 6.42 log cfu/g of sample, which higher than the recommended levels of 1.00 log cfu/g in food [35]. 57 % of the food samples had total aerobic plate count in the range of 2.67–8.89 log cfu/g of sample. *S. aureus* was present in almost half of 66 food samples analyzed ranging from 2.45 to 8.65 log cfu/g of sample which exceeds the satisfactory limits of 4 log cfu/g [36]. The presence of *S. aureus* above the satisfactory limit is a clear indication of the poor personal hygiene of the person handling the food [37]. Another indication of poor personal hygiene and food preparation is the presence of coliform bacteria, in this study one third of the samples contained Coliform bacteria with levels between 2.543 and 8.477 log cfu/g of sample. Even though coliform bacteria were not found in all samples, the reported data is alarming since the satisfactory limits of coliform in food is 1.00 log cfu/g [38]. Finally, *Listeria monocytogenes* was detected in around 20 % of the samples, posing a significant concern given the bacterium's ability to grow and multiply under refrigeration conditions where these foods are stored. A previous study by Farias et al. [39] that evaluated the food safety conditions of home kitchens in Brazil, classified them as medium risk, which is in line with the finding of this study. Most of the foods that are available online through Tajrat have high fat content (Table 4) which is one of the main factors that increase the risk of obesity and cardiovascular diseases [40]. Previous studies have indicated that eating fast foods and RTE foods outside the home is linked to consuming more saturated fat, sodium, and other unhealthy ingredients that will eventually increase the risk of obesity and cardiovascular diseases [41]. Therefore, the finding of this current study highlighted the importance of monitoring, licensing, and auditing such home-based online businesses in UAE to control and reduce the risk of foodborne diseases caused by improperly prepared RTE homemade foods.

5. Conclusion

Unregulated food service providers, Tajrat, in the UAE pose a significant risk of FBD outbreaks, as they may not follow effective safe food handling practices in the preparation, packaging, and distribution of meals to consumers. In this study we provided evidence that there was widespread use of Tajrat food service provides across the UAE, with around 50 % of the surveyed participants indicated that they purchase RTE foods online. The data highlighted that many consumers were unaware of risks posed by poor food hygiene and did not follow shelf life and other food safety instructions. Moreover, the taste (77 %), hygiene (72 %), convenience (52 %), and service quality (49 %) were the main factors that encourage customer RTE foods online as well as making customers choose one trader over the other. The obtained results also showed that there was significant microbiological contamination of food products sold by Tajrat on social media, confirming the risk of FBD. This data should inform the regulation and enforcement of all food service provision on social media across the UAE, to ensure proper food safety, and prevent significant burdens associated with FBD.

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Informed consent statement

Informed consent was obtained from all subjects involved in the study.

Data availability statement

All data generated or analyzed during this study are included in this published article. This study/survey was approved by Social Science Research Ethics Committee SScECR in UAEU with approval form number of ERS_2018.5777.

CRedit authorship contribution statement

Hussein Mostafa: Writing – review & editing, Writing – original draft, Methodology, Formal analysis. **Ayesha Al Dhaheri:** Writing – review & editing, Conceptualization. **Jack Feehan:** Writing – review & editing. **Nuha M.K.Yousif:** Writing – review & editing, Supervision, Resources, Methodology, Investigation, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.heliyon.2024.e24624>.

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