Hygienic-sanitary and cold chain standards applied to ground beef in some Mexican retail stores

Gabriela Casarotto-Daniel[1]
Ema Maldonado[2]
Pedro Arturo Martinez-Hernandez[1]
Jose L. Zaragoza-Ramirez[1]
Luis A. Miranda-Romero[1]
Citlalli C. González-Ariceaga[1]

[1]Departamento Zootecnia/Posgrado en Producción Animal, Universidad Autónoma Chapíngo, Texcoco, Estado de México, Mexico

[2]Departamento Zootecnia/Posgrado en Producción Animal, Universidad Autónoma Chapíngo, Texcoco, Estado de México, Mexiko

Abstract

Global current demands of foods have led to increasingly stringent requirements in the efficient management of hygienic-sanitary and cold chain standards/procedures of perishable foods to ensure food safety. The aim of this study was to determine the hygienic-sanitary and the cold chain standards applied to ground beef by four retail food stores located in the state of Mexico, Mexico, during fall and winter. Hygienic-sanitary and cold chain conditions were monitored by on-site inspection; temperature readings were taken at three positions within open refrigerated displays. Hygienic-sanitary features were not subjected to statistical analysis, temperature readings were statistically analyzed with retail store, season and position within the rack as sources of variation. All four stores need to improve their hygienic-sanitary ranks, mainly in the employees' protective clothes. Stores showed no difference ($p>0.05$) in temperature within displays, all registered mean temperatures above 4°C. Temperature was different ($p\leq0.05$) among positions within the rack, rear position showed a mean temperature of 3.8°C, up to three degrees lower than the front position. Winter season registered a mean temperature around 3°C, almost five degrees lower than fall. It was concluded that all four stores need to improve the hygienic-sanitary and temperature control to have packaged ground beef with higher food safety.

Keywords: Food safety, product quality, cold chain, animal products

Introduction

In Mexico, ground beef is a widespread commodity sold to final consumers in retail stores, where it is handled raw before set in refrigerated open displays to be picked up by consumers. Ground beef manipulated away from food safety norms has been identified as source of disease outbreaks [1], [2]. Retail stores have to secure the implementation on site of food safety norms and hygienic-sanitary inspection in situ along with objective evidences of such [3]; in addition, official inspectors check the retail stores' own control, facilities, and documentation [4]. Fleetwood et al. [5] concluded that food businesses with a closer compliance to the food hygiene law showed a lower microbiological contamination and then lower risk of promoting foodborne illness in their customers. Food-handling practices without the implementation of protocols for protection from microbiological contamination were associated with outbreak occurrences [6]. Inspection scores of food businesses have been applied to provide consumers with a greater certainty and maintain the required level of food safety in the shelf life of perishables [7].

Shelf life of perishables depends on temperature [8], food exposed to high temperatures showed a shorter shelf life [9]. Then, temperature monitoring and control food products are exposed to throughout the entire food supply chain have to be implemented to reduce food waste and risk of foodborne diseases and to increase shelf life [10], [11], [12]. Food quality and safety require specific temperatures along all cold chain links, in addition, compliance with these temperature requirements matches with consumers' growing expectancy regarding eating healthy foods [13]. The efficient management of cold chain conditions is a key point in food safety and prevention of foodborne diseases [14], [15].

Then, the objective of this study was to determine the hygienic-sanitary and cold chain standards applied to ground beef handling and display within premises of four retail stores located in the state of Mexico,

10.5680/lhpfsc000004

Mexico, by on-site inspection to provide information on how suitable these stores are regarding food safety.

Materials and methods

The study was based on on-site inspections of four major retail stores settled in the State of Mexico. The inspections consisted of a hygienic-sanitary evaluation and temperature recording. The hygienic-sanitary evaluation followed protocols published elsewhere [16], [17] specific item was the degree of cleanliness of six components: employees, handling room, equipment, the service area and its surrounding area, and the self-service area. Three features were scored in the employee's component: wearing protective clothes (aprons, hairnets, hoods, coveralls and overalls), the condition of protective clothes, and how clean they were; in handling room, the following features were scored: tools and material set in order, number of meat pieces exposed at one time and cleanliness of the whole room; in the service area, cleanliness of floor and displays were scored independently; and, for the self-service area, cleanliness of floor and working cold displays.

Then 11 features were scored with a score scale from 1 to 5, score 1 was 'dirty', 'not in use' or 'in very poor condition', while score 5 was total compliance of cleanliness, order and condition with standards. Hygienic-sanitary achievement percent was calculated as the sum of scores divided by 55, times 100, 55 is the maximum possible amount of points (5 x 11). Hygienic-sanitary rating was given depending on hygienic-sanitary achievement percent as follows: 'very bad' 0-20%; 'bad' 21-40%; 'regular' 41-60%; 'good' 61-80%; and 'very good' 81-100%. The hygienic-sanitary evaluation was done once in each of the four retail stores in fall and winter seasons. Scoring was done by the same person in both seasons and all four retail stores.

Temperature readings were taken in the open refrigerated display where ground beef was set, readings were at the front, middle and rear of the deck. Temperature readings were done in the same display at weekly intervals all fall and winter, a total of 12 readings per season, the same infrared thermometer was used all along.

Hygienic-sanitary rating was not statistically analyzed; while temperature readings were examined by analysis of variance with the main variation sources: retail store (four), place within the deck (three), season of the year (two), and first-degree interactions, weekly readings were the replications. All calculations were done by PROC GLM of SAS [18], mean separation was by Tukey ($\alpha = 0.05$).

Results and discussion

Hygienic-sanitary scores and ratings of the four retail stores in fall and winter seasons are shown in table 1. In fall, all four stores were rated within the category 'good', in this season store 4 scored low in cleanliness of the protective clothes worn by employees delivering the ground beef, while store 2 scored low in the number of meat pieces exposed at one time; employees took out many meat pieces at one time, leaving raw meat exposed while working on other meat pieces. All four stores showed room for improvement on all features evaluated for the hygienic-sanitary ground beef handling and display surrounding area.

Table 1: Hygienic-sanitary scores and ratings of four retail stores located in the state of Mexico, Mexico, that sale packaged ground beef, scores taken in two seasons.

W = wearing protective clothes; C = condition of protective clothes; Cl = cleanliness; O = order of tools and materials; PE = number of meat pieces exposed at one time; ClF = cleanliness of floor; ClR = cleanliness display equipment; W = working of cold displays

	Employees			Handling room			Equipment	Service area		Self-service area		
Store	W	C	Cl	O	PE	Cl	Cl	ClF	ClR	Cl	W	Rating
							Fall					
1	3	3	3	3	3	3	3	4	4	4	4	Good
2	4	4	4	3	2	3	3	4	4	4	3	Good
3	3	3	3	3	4	4	4	3	3	3	3	Good
4	3	3	2	3	3	3	3	3	4	4	4	Good
							Winter					
1	3	3	3	2	2	2	3	3	4	4	4	Regular
2	4	3	3	4	3	4	4	4	4	4	3	Good
3	3	3	3	4	4	3	3	3	3	3	3	Good
4	3	2	2	3	3	2	3	3	4	3	4	Regular

In winter, stores 1 and 4 showed lower rating than in fall, they went down from 'good' to 'regular'. Store 1 scored poorly in the three features of the handling room component, tools and materials laid without any evident order, too many meat pieces were on working tables waiting to be processed, and cleanliness was poor. Store 4 dropped in classification in winter due to a lower score in protective clothes condition and cleanliness of handling room compared to fall evaluation.

Hygienic-sanitary scores in all four stores were higher in both seasons in the self-service area, it could be said that managers of these stores showed a tighter supervision on this area as it was the area that customers were closer to. De Carvalho et al. [19] conducted a similar study in Rio de Janeiro, Brazil, mapping microbiological risk points in a food sales unit. In that study they identified critical points regarding the personnel, since they handled food with hair uncovered, incomplete preventive clothes, talking close to the food without mouth covers, equipment and tools poorly cleaned, and the unqualified performance of the responsible employees. In this case, the top priority in the food chain is related to safety, which is directly a responsibility of industry and retailers when offering the food products [20].

Guiducci et al. [13] mentioned that an important focus is on the cleanliness and temperature management of refrigeration equipment. Lack of cleanliness leads to contamination of unpackaged products and those being handled by employees, whilst lack of temperature holding of food products leads to unsafe food. Caggiano et al. [21] highlighted the need and importance of health surveillance in food for preserving shelf life. Furthermore, the results of the inspections can be used as preliminary reports to consumers [22]. Then, prevention of food contamination should be important for enterprises marketing food, yet few establishments comply with all existing standards. Unfortunately, consumers themselves are not aware of the importance of hygiene and good health practices [23]. Fleetwood et al. [5] indicated that surveillance and current policies are key factors in raising hygiene standards in food establishments, which represents an important link with the potential benefits related to disease reduction.

All four retail stores showed the same ($p>0.05$) mean temperature when averaged from the three deck positions (front, middle and rear) and two seasons (fall and winter), the overall mean temperature for the four retail stores was 5.5°C (table 2), it can be said that none of the four stores complied with the standard of 4°C set as an official regulation for refrigeration of meat products. Then, all four stores showed an unacceptable deviation from the optimal temperature to assure food safety [24].

Table 2: Temperature (mean ± standard deviation) in open refrigerated displays where packed ground beef is laid out for sale in four retail stores of the state of Mexico, Mexico (average from temperature readings in three locations within the deck and within two seasons)

Retail store	Temperature (°C)
1	4.8±1.1
2	4.9±1.4
3	6.9±2.6
4	5.3±1.3

A study in France measured the temperature of some perishable products in 20 small shops (bakeries, butchers and dairy shops), finding that 63% of temperatures were above 7°C [9]. In a similar study from Slovenia, food store cold chain was evaluated and findings were that there were temperature abuses and differences in temperature between temperatures indicated on the shelves and those recorded on the measuring devices [16]. Similarly, alterations in the temperature of animal products during air transport are reported [25]. In addition, Morelli et al. [3] showed that 70% of the temperature records reported increases in freezing food boxes of animal origin in France. They also reported the association of this temperature abuse with poor professional practices and deficiency in refrigeration design equipment, and suggested the storage of products according to the equipment manufacturer's instructions. In the study carried out in Finland, similar temperature abuses were reported in 50% of fish, meat and ready-to-eat foods during temperature monitoring in retail sales [25].

Temperature within the open refrigerated display was not the same ($p \leq 0.05$), there was a gradual increase in temperature from the rear (3.5°C) to the front (7°C) positions of the display. The rise in temperature described was observed in all four stores and in both seasons. Refrigerators could not keep a homogenous temperature throughout. Only the temperature at the rear position complied with the temperature standard set by the respective Mexican legislation (Mexican Official Standard, NOM-251-SSA1-2009). Then it can be said that in these store foods, safety depends on the position of the package of ground beef within the open refrigerated display, the closer the ground beef is to the consumer’s hand the highest is the risk of getting unsuitable meat to eat.

Lundén et al. [4] marked out a disparity over a three-month period between temperature data documented in meat and fish products and those collected during the on-site inspection. The abuse of temperature in the cold chain is due to many factors, according to a report by Ndraha et al. [26], who indicated that the practices of the food operators in food cold chain, the design of the refrigeration equipment, as well as the positions of the product packages in the display container are those components that cause food deterioration. Several authors mention that the last steps of food cold chain are highly critical, therefore keeping temperature under control is one of the most important parameters, since, with the presence of higher temperatures during storage, faster microbial growth and food deterioration take place [8], [27].

The season of the year showed an influence ($p \leq 0.05$) on the temperature within open refrigerated displays for ground beef. All winter long the temperature was under 4°C, while in fall it was above 8°C, over four degrees higher. Fall season turned out to be the season in which a tighter supervision on temperature within the displays has to be applied if retail stores try to reach a higher food safety rank in the ground beef they sell. Zubeldia et al. [28] registered temperature abuse in refrigerated displays of retail stores in Spain over summer mainly in the upper racks. These breaks in the cold chain significantly reduced the shelf life of various perishable products. Therefore, the authors proposed in the study, to review the operating procedures in those stores, in order to verify compliance with the existing regulations. Brown et al. [29] found that temperature abuse in refrigerated displays was more frequent in spring and summer.

Maintaining the food cold chain throughout the marketing food process is essential to ensure food quality and safety and health. In addition, it is necessary to provide adequate hygiene in all establishments [30].

In many cases, retail food stores do not directly measure the temperature of perishable products; however, the temperature indicated in standards is crucial for food safety, and a high percentage of abuses go unnoticed by the operators of retail food centers [16]. To have temperature data in real time, it is necessary to implement a monitoring system that can be verified and measurable and reports temperature at any time [24]. The majority of abuses in temperature are reported in developed countries, because of the low availability of studies carried out in developing countries [15].

Conclusions

Hygienic-sanitary and cold chain standards applied to ground beef handling and display within premises of the four retail stores located in the state of Mexico, Mexico, have to be improved to increase food safety in ground beef. Weakest hygienic-sanitary features are the cleanliness of employees' clothes and condition of protective clothes, and handling room cleanliness and order, while the strongest feature is self-service area cleanliness. In all four retail stores keeping cold chain in open refrigerated displays is poor and dependent on the position within the deck and the season of the year. Improvement in temperature control devices within refrigerated open displays is also an important factor to assure that a cold chain keeps packaged ground beef with low risk of short shelf life.

References

1. El-Bawab N. CDC suspects ground beef is the source of recent E. coli outbreak. CNBC [Internet]. 2019 Apr 12 [cited 2021 Mar 12]. Available from: https://www.cnbc.com/2019/04/12/cdc-suspects-ground-beef-is-the-source-of-recent-e-coli-outbreak.html
2. Rettener R. The source of that mysterious E. coli outbreak has likely been found. Live Science [Internet]. 2019 Apr 12 [cited 2021 Mar 12]. Available from: https://www.livescience.com/65224-e-coli-outbreak-ground-beef.html
3. Morelli E, Noel V, Rosset P, Poumeyrol G. Performance and conditions of use of refrigerated display cabinets among producer/vendors of foodstuffs. Food Control. 2012 Aug;26(2):363-68. DOI: 10.1016/j.foodcont.2012.02.002
4. Lundén J, Vanhanen V, Myllymäki T, Laamanen E, Kotilainen K, Hemminki K. Temperature control efficacy of retail refrigeration equipment. Food Control. 2014 Nov;45:109-14. DOI: 10.1016/j.foodcont.2014.04.041
5. Fleetwood J, Rahman S, Holland D, Millson D, Thomson L, Poppy G. As clean as they look? Food hygiene inspection scores, microbiological contamination, and foodborne illness. Food Control. 2019 Feb;96:76-86. DOI: 10.1016/j.foodcont.2018.08.034
6. Firestone MJ, Eikmeier D, Scher D, Medus C, Hedeen N, Smith K, Hedberg CW. Can aggregated restaurant inspection data help us understand why individual foodborne illness outbreaks occur? J Food Prot. 2020 Jan 13;83(5):788-93. DOI: 10.4315/JFP-19-576
7. Aik J, Newall AT, Ng LC, Kirk MD, Heywood AE. Use of the letter-based grading information disclosure system and its influence on dining establishment choice in Singapore: A cross-sectional study. Food Control. 2018 Aug;90:105-12. DOI: 10.1016/j.foodcont.2018.02.038
8. Bruckner S, Albrecht A, Petersen B, Kreyenschmidt J. Influence of cold chain interruptions on the shelf life of fresh pork and poultry. Int J Food Sci Technol. 2012 May;47(8):1639-1646. DOI: 10.1111/j.1365-2621.2012.03014.x
9. Montanari R. Cold chain tracking: a managerial perspective. Trends Food Sci Technol. 2008 Aug;19(8):425-31. DOI: 10.1016/j.tifs.2008.03.009
10. Aung MM, Chang YS. Temperature management for the quality assurance of a perishable food supply chain. Food Control. 2014 Jun;40:198-207. DOI: 10.1016/j.foodcont.2013.11.016
11. Buelvas Salgado GA, Patiño Gómes JH, Restrepo Flores CE. Efecto de la cadena de frîo sobre el crecimiento de bacterias ácido-lácticas, la calidad fisicoquîmica y la alteración de jamones cocidos lonchados empacados al vacîo. Revista Lasallista de Investigación [Internet]. 2012 [cited 2020 Sep 22];9(2):55-64. Available from: http://repository.lasallista.edu.co:8080/ojs/index.php/rldi/article/view/327
12. Kuo JC, Chen MC. Developing an advanced multi-temperature joint distribution system for the food cold chain. Food Control. 2010 Apr;21(4):559-66. DOI: 10.1016/j.foodcont.2009.08.007
13. Guiducci G, Copeland F, Dorsey T, Edelstein S. A review of the food establishment inspection reports in Boston, Massachusetts. Top Clin Nutr. 2011 Apr/Jun;26(2):165-70. DOI: 10.1097/TIN.0b013e31821930d0

Forbidden

You don't have permission to access this resource.

14. Likar K, Jevšnik M. Cold chain maintaining in food trade. Food Control. 2006 Feb;17(2):108-13. DOI: 10.1016/j.foodcont.2004.09.009
15. Mercier S, Villeneuve S, Mondor M, Uysal I. Time–temperature management along the food cold chain: a review of recent developments. Comprehensive Reviews in Food Science and Food Safety. 2017 May 29;16(4):647-67. DOI: 10.1111/1541-4337.12269
16. Lundén J, Vanhanen V, Kotilainen K, Hemminki K. Retail food stores' internet-based own-check databank records and health officers' on-site inspection results for cleanliness and food holding temperatures reveal inconsistencies. Food Control. 2014 Jan;35(1):79-84. DOI: 10.1016/j.foodcont.2013.06.050
17. Secretaría de Salud. 2020. Ley General de Salud. Reglamento de la ley general de salud en materia de control sanitario de actividades, establecimientos, productos y servicios. [cited 2020 Sep 22]. Available from: http://www.isademexico.com/filesdownload/salud/reglamentos/RLGSMCSAEPS/RLGSMCSAEPS.
18. SAS (Statistical Analysis System). SAS/STAT 9.3 User's Guide. Cary (NC): SAS Institute Inc.; 2011.
19. De Carvalho LR, Maia Franco R, Rodrigues de Farias Filho J. Mapeamento de riscos microbiológicos no processo produtivo da carne bovina em uma unidade de alimentação e nutrição [Mapping of microbiological risks in the production of bovine meat at a food service]. Demetra. 2012;7(1):23-38. DOI: 10.12957/demetra.2012.3276
20. Arispe I, Tapia MS. Inocuidad y calidad: requisitos indispensables para la protección de la salud del consumidores. Agroalimentaria. 2007 Jan-Jun [cited 2020 Sep 22];13(24):105-18. Available from: https://www.redalyc.org/pdf/1992/199216580008.pdf
21. Caggiano G, Diella G, Trerotoli P, Lopuzzo M, Triggiano F, Ricci M, Marcotrigiano V, Montagna MT, De Giglio O. A pilot survey on hygienic-sanitary characteristics of ready-to-eat sauces and pesto. Int J Environ Res Public Health. 2020 Jul;17(14):5005. DOI: 10.3390/ijerph17145005
22. Vainio A, Kaskela J, Finell E, Ollila S, Lundén J. Consumer perceptions raised by the food safety inspection report: does the smiley communicate a food safety risk? Food Control. 2020 Apr;110: 106976. DOI: 10.1016/j.foodcont.2019.106976
23. Carrasco E, Morales-Rueda A, Garcîa-Gimeno RM. Cross-contamination and recontamination by Salmonella in foods: a review. Food Res Int. 2012 Mar;45(2):545-56. DOI: 10.1016/j.foodres.2011.11.004
24. National Restaurant Association. Inside the minds of today's consumers: why restaurants are poised for success in 2011 and beyond [Internet]. 2011 [cited 2012 Nov 30]. Available from: https://www.yumpu.com/en/document/view/6391582/the-mind-national-restaurant-association
25. Mai NTT, Margeirsson B, Margeirsson S, Bogason SG, Sigurgísladóttir S, Arason S. Temperature mapping of fresh fish supply chains – air and sea transport. J Food Process Eng. 2012 Aug;35(4):622-56. DOI: 10.1111/j.1745-4530.2010.00611.x
26. Ndraha N, Hsiao HI, Vlajic J, Yang MF, Lin HTV. Time-temperature abuse in the food cold chain: review of issues, challenges, and recommendations. Food Control. 2018 Jul;89:12-21. DOI: 10.1016/j.foodcont.2018.01.027
27. Raab V, Bruckner S, Beierle E, Kampmann Y, Petersen B, Kreyenschmidt J. Generic model for the prediction of remaining shelf life in support of cold chain management in pork and poultry supply chains. J Chain Netw Sci. 2008 Jun;8(1):59-73. DOI: 10.3920/JCNS2008.x089
28. Zubeldia BB, Jiménez MN, Claros MTV, Andrés JLM, Martin-Olmedo P. Effectiveness of the cold chain control procedure in the retail sector in Southern Spain. Food Control. 2016 Jan;59:614-18. DOI: 10.1016/j.foodcont.2015.06.046
29. Brown W, Ryser E, Gorman L, Steinmaus S, Vorst K. Transit temperatures experienced by fresh-cut leafy greens during cross-country shipment. Food Control. 2016 Mar;61:146-55. DOI: 10.1016/j.foodcont.2015.09.014
30. Adekomaya O, Jamiru T, Sadiku R, Huan Z. Sustaining the shelf life of fresh food in cold chain – a burden on the environment. Alex Eng J. 2016 Jun;55(2):1359-65. DOI: 10.1016/j.aej.2016.03.024

Corresponding authors: Professor Dr. Ema Maldonado, Universidad Autónoma Chapíngo, Departamento Zootecnia/Posgrado en Producción Animal, Km. 38.5 Carretera México-Texcoco, Chapi, 56230 Texcoco, Estado de México, Mexiko, Phone: +52-595-9521621, E-mail: emamaldonado@correo.chapingo.mx

Forbidden

You don't have permission to access this resource.

Citation note: Casarotto-Daniel G, Maldonado E, Martinez-Hernandez PA, Zaragoza-Ramirez JL, Miranda-Romero LA, González-Ariceaga CC; Universidad Autonoma Chapingo. Hygienic-sanitary and cold chain standards applied to ground beef in some Mexican retail stores. In: Kreyenschmidt J, Dohlen S, editors. Living Handbook of Perishable Food Supply Chains. Cologne: PUBLISSO; 2016-. DOI: 10.5680/lhpfsc000004