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Short communication

Temperature increase of foods in car trunk and the potential hazard for microbial growth

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ABSTRACT

This study assessed the potential microbial hazard posed by temperature increases on refrigerated and frozen food stored in car trunk exposed to sunlight. The internal temperatures in the trunk and of food items (egg, milk, tofu, fresh meat, and frozen meat) stored in it during summer were measured at 10 min intervals for up to 3 h (12:00 PM to 15:00 PM). Trunk temperature steadily increased from 32.3 °C up to 41.5 °C, with longer exposure times. Food temperature also increased substantially during this period, reaching 33.5 °C (frozen meat), 35.3 °C (milk), 35.6 °C (tofu), 37.0 °C (egg), and 38.4 °C (fresh meat). Cloud cover and solar radiation affected car and food temperature, with lower cover and higher radiation associated with higher food temperatures (7.1 °C higher in the car trunk when compared to a situation of extensive cloud cover and low radiation, and 6.9 °C higher for eggs, 5.9 °C for milk, 5.0 °C for tofu, and 7.4 °C and 5.5 °C for fresh and frozen meat, respectively). The temperature of refrigerated foods (egg, milk, and fresh meat) reached 20 °C within 40 min (tofu: 60 min) and 30 °C within 90–110 min (tofu: 130 min). The temperature of frozen meat reached to danger zone (5–60 °C), which is associated with bacterial growth, after 90 min. Consumers should therefore realize the importance of time–temperature control, particularly in warm and sunny weather. Purchased foods should be transferred to a refrigerated environment as fast as possible, and the car trunk should be avoided. The present results can be used for consumer education, contributing to the recognition of the importance of food safety.

1. Introduction

Food safety is a growing concern of consumers and is of crucial importance to the industry and economy (Jevšnik, Hlebec, & Raspor, 2008; Kwak, Kim, & Rhee, 2011; Röhr, Lüddecke, Drusch, Müller, & Alvensleben, 2005; Scheule & Sneed, 2001). Proper food handling is important at all stages, including production, processing, storage, distribution, and preparation, both to ensure stability in the biochemical and physical properties of food and microbiological safety for consumption.

Although consumers tend to associate foodborne disease with eating outside home, many foodborne diseases are caused by food prepared at home (Griffith, Mathias, & Price, 1994; Redmond & Griffith, 2003). Proper handling and preparation practices at home have been identified as critical in this regard (Altekruse, Street, Fein, & Levy, 1996; Unusan, 2007). When interviewed, approximately 50% of consumers in the USA indicate that they use the car trunk to transport food from the grocery to their homes (Geuens, Brengman, & S'Jegers, 2003; Godwin & Coppings, 2005). In Korea, 50.3% of consumers also indicated that they use the car trunk to transport food items purchased at large discount and department stores (Kim, Jung, et al., 2011). However, as a consequence of the prolonged exposure of the car to direct sunlight, this behavior may cause the growth of microorganisms due to the increase in the internal temperature of food. Although the hazardous nature of this behavior is unquestionable, there is currently only limited information and quantification of its associated risk.

The objective of the present study is to assess the potential microbial hazard by increased temperature of food items that required time–temperature control to be safe for consumption (including egg, milk, tofu, fresh meat, and frozen meat) when placed in car trunk exposed to sunlight. Additionally, the effect of weather including cloud cover and solar radiation on car trunk and food temperature were also examined.

2. Materials and methods

The weight or size of egg, milk, tofu, fresh meat, and frozen meat samples were determined based on the most frequent sale unit. All

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Table 1
Outdoor temperature, cloud cover, and solar radiation at each trial.

Group	Trial	Average of outdoor temperature (°C)	Cloud cover[a]			Solar radiation[a] (MJ/m^2)
			12:00–13:00 PM	13:00–14:00 PM	14:00–15:00 PM	
Group A	1	32.6	5	5	6	17.9
	2, 3[b]	34.9	7	5	5	15.3
	6, 7	31.3	6	5	7	14.6
Group B	4, 5	33.2	0	1	3	22.3
	8, 9	34.4	0	0	0	21.1
	10, 11	35.5	1	1	1	21.1

[a] Data provided by the Korea Meteorological Administration for Jeung Reung (Seoul).
[b] Two trials performed on the same day using two cars.

samples were purchased from a local market in Seoul (Korea). A shell of a medium sized-egg (weight: 44–52 g) was broken with a pointed gimlet and a wire sensor of digital thermometer (TES 1300, TES Electrical Electronic Corp., Taipei, Taiwan) was placed into the center of egg and fixed with adhesive tape. In the case of milk and tofu, the thermometer was inserted into the center of a Tetra Pak milk box (200 mL) and in the center of a tofu (weight: 210 g, size: 9 × 6 × 3.5 cm). In the case of fresh and frozen meat,

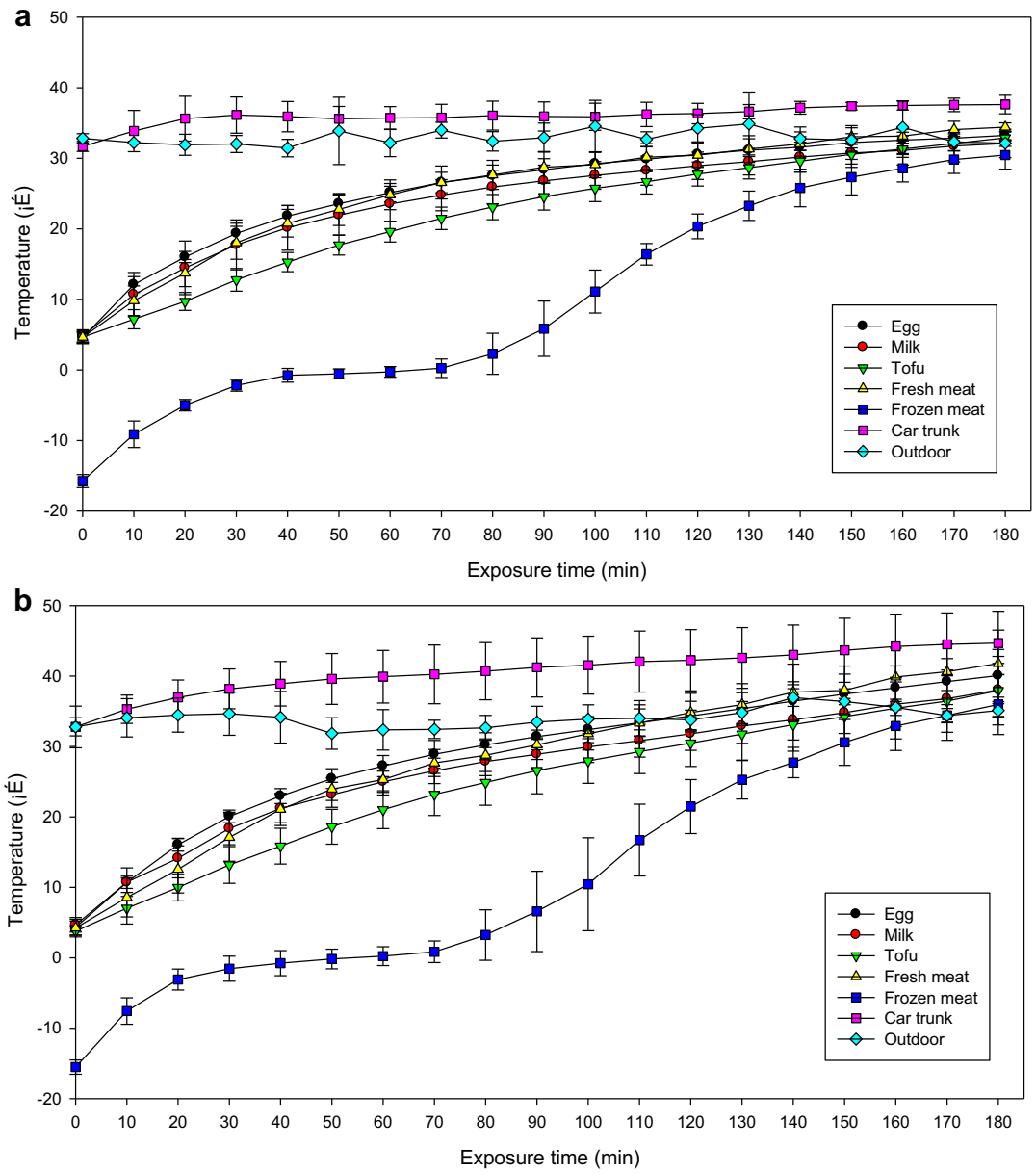

Fig. 1. The temperature outdoor, in the car trunk, and of food items (egg, milk, tofu, fresh meat, and frozen meat) stored in the car trunk under (a) a high cloud cover level and low level of solar radiation (Group A) and (b) a low level of cloud cover and high level of solar radiation (Group B).