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Analysis of Consumer Food-Handling Practices from Grocer to Home Including Transport and Storage of Selected Foods

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Consumers were interviewed about how they purchase, transport, store, and otherwise handle food. Emphasis was placed on handling of cold foods and home refrigeration. More than 70% of consumers took steps to protect cold foods during purchase and transport and more than 90% claimed to put away cold foods first. Only 7% of consumers used coolers to protect cold foods during transport. How consumers stored a variety of foods was determined and evaluated. Few consumers knew their own or correct refrigerator temperature and few had refrigerator thermometers.

A second interview and refrigerator checklist were completed in 200 of the consumers' homes at least a year later. Researchers judged that circumstances that might allow for cross-contamination existed in 41% of the refrigerators examined. A large percentage of refrigerators were above recommended temperatures.

There is a need to disseminate current food-safety and home-refrigeration information as consumer lifestyles adapt to the changing global economy. Consumers need to assume responsibility for temperature control of foods within their homes.

Implementation of systematic Hazard Analysis and Critical Control Point (HACCP) management plans has allowed many food-production, manufacturing, and distribution industries to identify, evaluate, and control specific critical points where the safety of foods or food products is at highest risk or could be compromised by a biological, chemical or physical hazard (FDA 1997). HACCP, in combination with research advances, has made it possible to reduce the incidence of some food-borne illnesses (CDC 2003). Consumer transport, storage, and handling represent the last critical control points in food distribution.

Numerous scientific advances and socio-economic changes have greatly impacted the lifestyles of consumers, including how they purchase, store, and prepare foods (Collins 1997). Transport of foods by consumers from the retail grocer to their homes and subsequent storage and handling of those foods within the home are under-studied aspects of food distribution and safety. It is imperative to thoroughly examine all steps in the food chain as the food industry strives to continue to provide American consumers with a great variety of safe foods of high quality. We have collected data for several years to evaluate consumer handling of cold foods and their home-refrigeration knowledge and practices. This article describes aspects of this work relevant to food distribution.

Methods

Phase 1

Trained interviewers completed a total of 551 face-to-face interviews in six states, in such places as community centers and churches. Respondents represented a broad cross-section of adult consumers who played a role in or were familiar with the food purchasing and handling practices used in their households. The questionnaire consisted of eight sections dealing with different aspects of food handling. Content and format of the questionnaire were evaluated by liaisons at the Food and Drug Administration. Human-subjects approval was received before the interviews began.

Phase 2

Approximately one year after Phase 1, 200 of the 551 consumers participated in Phase 2 of the study, which included an in-home interview and completion of a checklist by a researcher on the condition and contents of the home refrigerator.

Data Analysis

All survey responses and checklist findings were numerically coded where possible and entered into SPSS-PC. Frequency analysis and chi-square tests were applied to evaluate the data.

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Results and Discussion

Food Transport

The majority of consumers went food shopping either once a week (44%) or every two weeks (28%). Fifteen percent went twice a week and 9% once a month. Less than two percent went food shopping daily or less than once per month. Slightly more than half of the consumers in our study stated that they could return home from food shopping within 10 minutes, and a large majority, 83%, within 20 minutes (Table 1). This leaves 17% that required from 20 minutes to over an hour to return home with purchased food, an interval possibly long enough for the temperature of cold foods to rise, allowing an opportunity for food-borne organisms to multiply. It seems probable that consumers underestimated the time taken to return home, especially for the lowest intervals, considering only the driving time and not including the time required to load and unload purchased food from their vehicle.

Table 2 shows results for certain consumer behaviors associated with food shopping. About half

of consumers always or often run other errands while food shopping, while only 8% never did so. Few consumers consistently go to more than one store but 41% occasionally do so; slightly more than one-third never go to more than one store. Running errands and going to more than one store are behaviors that might allow for an increase in the temperature of cold foods, possibly permitting microbial growth. Overall, more than 70% of consumers always or often placed cold foods in their shopping carts last, placed cold foods together in their shopping carts, and bagged cold foods together. Ninety-three percent claimed to always or often put away cold foods first when they get home. These are desirable behaviors for protecting cold foods while in transit.

It would be logical to surmise that those persons who required a longer time to return home with purchased food might take greater measures to maintain the temperature of cold foods. Approximately the same proportion of consumers who returned home in 20 minutes or less and those who took longer to return home always or often ran other errands while shopping (50% and 55%, respectively). A

Table 1. Time Required for Consumers to Return Home from the Grocery Store.

Time period	Number of Consumers	Percent
10 minutes or less	285	51
11–20 minutes	171	31
21–30 minutes	48	9
One half to one hour	31	6
Over one hour	16	3
Total	551	100

Table 2. Percentage of Consumers Performing Selected Behaviors While Food Shopping.

	Always	Often	Occasionally	Never
When food shopping				
I run other errands	14	37	41	8
I go to more than one store	10	13	41	37
Cold foods are				
placed in shopping cart last	39	32	21	8
placed together in cart	43	30	16	11
bagged together at checkout	39	28	16	17
put away first at home	78	15	5	2

somewhat greater proportion of consumers who took more than 20 minutes to return home always or often went to more than one store (32%) while food shopping, compared to those who return home in a short time (20%). It would be expected that persons living farther from available food-shopping outlets would consolidate their travel and visit more than one store even though this further increases the time during which the temperature of cold foods could increase. Interestingly, there were no significant differences among the percentage of consumers whose behavior served to protect cold foods during purchasing and transit. A majority of consumers performed these behaviors regardless of the time required to return home.

Only 7% of responding consumers used a cooler or icepacks while transporting food. However, there was a gradual increase in the percentage of consumers using a cooler as the time required to return home increased. Few consumers interviewed used insulated grocery bags or any type of insulated wrap to protect cold foods. Many consumers used a cooler, ice, or some other means when transporting cold foods to picnics or other outings. It appears

that consumers do not recognize the need or any possible advantage in employing these strategies when transporting purchased food home.

Consumers transported foods in a variety of locations within their vehicles, and commonly in more than one location (Table 3). The largest percentage placed foods in the trunk of their car or back of their pickup truck. One-quarter of respondents indicated that the location varied depending on the amount of food being transported. No pattern was detected in where foods were placed in consumers' vehicles and any other factor.

Consumer-Reported Refrigeration Practices

As reported elsewhere, few consumers had refrigerator thermometers, and those who did failed to check them regularly (Godwin et al. 2005). Many consumers apparently confused the temperature-setting dial in their refrigerator with a thermometer. Forty-three percent of consumers interviewed changed the dial setting on their refrigerators at least once a year (Table 4). Of the consumers who changed dial settings, two-thirds did so in response

Table 3. Location of Purchased Foods During Transport.

Location in vehicle	%
On seat in car	28
On floor in car	21
In trunk of car/back of pickup	52
In any/all depending on amount	25
I don't drive myself home	2

Table 4. Consumer Changing of Refrigerator Temperature-Dial Setting.

How often do you change the temperature-dial setting?	
Never	57*
Once/twice a year	66**
Every few months	24**
About once a month	7**
More than once month	3**
Reason for changing the temperature dial setting?	
Change with food temperature	66**
Change with seasons	20**
Other reason	14**

Total applicable cases = 514. No. consumers that changed dial = 202.

* Percent of total. ** Percent of consumers that changed dial.

to a perceived change in food temperature, while 20% changed dial setting with season of the year. Since few consumers use refrigerator thermometers, it appears to be common practice for consumers to judge the temperature of refrigerated foods by everyday experience, e.g., feeling milk jugs, juice containers or vegetables (Godwin, et al, 2005). This is certainly an inadequate method. Food-safety educators need to emphasize the consumer's pivotal role in maintaining control of food temperature.

Consumer-Reported Food Storage

Section 6 of our survey instrument consisted of an extensive food "grid" in which consumers were questioned regarding 31 foods or food categories (Table 5). More than half of the consumers interviewed had the foods listed on the grid in their homes, with the exceptions of uncooked fish and other seafood, cooked vegetables and beans, soft cheese, and yogurt.

Table 5. Consumer Food-Grid Responses: Is This Food Item in Your Home? Where Is This Food Item in Your Home?

Food Item	<u>In Home? # (%)</u>		<u>Where in home? # (% of Yes)</u>				
	Yes	No	Refrig.	Freezer	Cupboard	Counter	Other
Uncooked meat	469 (85)	82 (15)	83 (18)	441 (94)		3 (<1)	
Ground meat	411 (75)	140 (25)	48 (12)	387 (94)			1 (<1)
Luncheon meat	392 (71)	158 (29)	367 (94)	59 (15)	2 (<1)		1 (<1)
Cooked meat	300 (54)	250 (46)	259 (86)	60 (20)	1 (<1)		2 (<1)
Cured meat	306 (56)	244 (44)	215 (70)	119 (39)	2 (<1)		
Frankfurters	320 (58)	231 (42)	163 (51)	200 (63)			1 (<1)
Chicken	427 (78)	124 (22)	45 (11)	407 (95)	2 (<1)		3 (1)
Uncooked fish	217 (39)	334 (61)	10 (5)	205 (95)	4 (2)		
Other seafood	152 (28)	399 (72)	13 (9)	133 (88)	10 (7)		1 (<1)
Eggs	519 (94)	32 (6)	516 (99)	2 (<1)			
White potatoes	446 (81)	105 (19)	114 (26)	5 (1)	226 (51)	39 (9)	72 (16)
Raw vegetable	502 (91)	49 (9)	470 (94)	26 (5)	16 (3)	15 (3)	8 (2)
Cooked veggies	251 (46)	299 (54)	221 (88)	21 (8)	16 (6)		1 (<1)
Fluid milk	498 (90)	53 (10)	495 (99)	5 (1)	2 (<1)	1 (<1)	
Soft cheese	237 (43)	314 (57)	230 (97)	12 (5)			
Hard cheese	441 (80)	110 (20)	430 (98)	34 (8)	1 (<1)		
Fruit/open can	411 (75)	140 (25)	327 (80)	3 (1)	40 (10)	96 (23)	21 (5)
Vegetable oil	515 (94)	36 (6)	16 (3)		454 (88)	37 (7)	13 (3)
Peanut butter	467 (85)	83 (15)	65 (14)	2 (<1)	390 (84)	13 (3)	5 (1)
Butter/margarine	532 (97)	19 (3)	517 (97)	53 (10)	4 (1)	16 (3)	
Mayonnaise	516 (94)	35 (6)	513 (99)	1 (<1)	32 (6)	1 (<1)	
Tortillas	284 (52)	267 (49)	193 (68)	22 (8)	65 (23)	11 (4)	3 (1)
Uncooked beans	384 (70)	167 (30)	10 (3)	9 (2)	342 (89)	19 (5)	6 (2)
Cooked beans	194 (35)	357 (65)	128 (66)	17 (9)	46 (24)		5 (3)
Fruit juices	478 (87)	73 (13)	425 (89)	55 (12)	93 (19)	6 (1)	5 (1)
Soft drinks. etc.	473 (86)	78 (14)	377 (80)		65 (14)	28 (6)	40 (8)
Yogurt	270 (49)	281 (51)	260 (96)	16 (6)			
Catsup – open	497 (90)	54 (10)	458 (92)		40 (8)	3 (1)	1 (<1)
Jelly/jam – open	480 (87)	71 (13)	467 (97)	1 (<1)	22 (5)	4 (1)	1 (<1)
Bread, etc.	522 (95)	29 (5)	161 (31)	82 (16)	143 (27)	189 (34)	43 (8)
Beer, wine, etc.	289 (53)	260 (47)	229 (79)	2 (1)	79 (27)	21 (7)	16 (6)

Meat: Most consumers had uncooked meat, ground meat, and poultry in their homes (85, 75, and 78%, respectively); however, only a small percentage had these meats in their refrigerators (Table 5). This observation is of interest for several reasons. Many people associate meat with food-borne illness even though many documented incidences of illness have been traced to produce and other foods (Ollinger-Snyder and Matthews 1996). Current technology available in the majority of homes today allows consumers to freeze purchased meat and then later rapidly defrost the meat in a microwave oven, prepare it, and consume it all within a short period of time. Consequently, raw meats may never be stored in the refrigerator at any time, or perhaps only for short periods, reducing the risk for cross contamination of other foods. Indeed, Table 6 shows that uncooked meat, ground meat, chicken, and uncooked fish were in consumer’s refrigerators often for only a day and rarely for more than three days.

Improperly refrigerated meats may contribute to cross-contamination of other foods. Meat juices can contaminate other foods when meats are stored

above them in the refrigerator. Table 7 indicates where consumers placed a selection of foods within their refrigerators. Of the few consumers having uncooked meat and ground meat in the refrigerator, 43% had these foods in the meat compartment or on the bottom shelf of the refrigerator, locations not likely to lead to cross-contamination. It was surprising that 14% of consumers had ground meat, 20% uncooked fish, and 6% each chicken and uncooked meat in the fruit or vegetable compartments of their refrigerators. Certainly other foods in these areas would be at risk for cross-contamination.

Ready-to-Eat Foods: Compared to uncooked meats, more consumers had luncheon meats and frankfurters, two ready-to-eat (RTE) foods, and also cured meats, in their refrigerators (Table 5) and for longer periods of time (Table 6). Also, a larger proportion of consumers stored these foods in the meat compartment. Still, these foods are often stored on the middle or bottom shelves of a large number of refrigerators where cross contamination would be possible. Consumers commonly stored

Table 6. Consumer Food-Grid Responses: How Long Has This Food Been in Your Rrefrigerator?

Food Item	1 day or less	2–3 days	4 days– week	1 to 2 weeks	3 weeks– 1 month	Over 1 month
Uncooked meat	42*	44	9	6	—	—
Ground meat	38	47	15	—	—	—
Chicken	36	38	18	2	—	1
Uncooked fish	60	30	10	—	—	—
Luncheon meat	8	24	43	20	4	1
Frankfurters	5	17	44	23	9	3
Cured meat	7	20	35	28	7	3
Raw vegetables	4	14	42	34	6	3
White potatoes	4	5	20	32	25	13
Cooked meat	30	47	19	3	<1	<1
Cooked vegetables	23	50	20	5	1	<1
Fruit or open can	6	20	37	25	8	4
Bread	6	14	42	29	7	1
Eggs	4	10	31	39	13	4
Mayonnaise	1	3	8	27	35	25
Fluid milk	11	30	46	14	<1	—
Soft cheese	2	11	34	38	13	2
Hard cheese	4	10	27	34	18	8
Yogurt	6	18	45	23	5	4

* Percent of respondents; N = 551.

Table 7. Consumer Food-Grid Responses: Where in Refrigerator Do You Keep These Food Items?

Food Item	Top shelf	Middle shelf	Bottom shelf	Meat compart.	Door	Fruit/veg. compart.
Uncooked meat	22*	35	29	13	—	6
Ground meat	8	33	38	8	—	14
Chicken	11	29	52	—	—	6
Uncooked fish	—	50	30	—	—	20
Luncheon meat	6	20	8	42	5	21
Frankfurters	6	21	11	34	11	18
Cured meat	11	18	20	27	4	22
Raw vegetables	1	3	5	<1	1	98
White potatoes	—	3	9	—	2	84
Cooked meat	18	49	32	2	—	3
Cooked vegetables	16	60	28	1	—	1
Fruit or open can	6	12	11	2	1	71
Bread	20	36	43	<1	4	4
Eggs	11	27	22	2	40	<1
Mayonnaise	13	14	7	—	69	<1
Fluid milk	58	13	14	—	17	<1
Soft cheese	7	20	11	23	33	8
Hard cheese	6	15	10	32	26	13
Yogurt	31	33	16	—	20	4

* Percent of respondents; N = 551.

the RTE and cured meats in their refrigerators from several days to 2 weeks (Table 6). Extended refrigerator storage increases time available for cross-contamination and spoilage.

Cross-contamination: Tables 6 and 7 also present information regarding several other foods that might be subject to cross-contamination from improperly stored meat. These would include raw vegetables, white potatoes, fruit, bread, and leftovers such as cooked meat and vegetables. These foods were occasionally stored on the middle and bottom shelves of the refrigerator. This was especially true for leftovers (81% and 88% for cooked meat and cooked vegetables, respectively) and bread (79%). Raw vegetables and fruit were predominantly, but not exclusively, stored in the fruit and vegetable bins. Most of these food items were refrigerated for relatively extended times, up to several weeks.

Other Food Concerns: Forty percent of consumers stored eggs in the door of their refrigerators. Data (Godwin, Speller-Henderson, and Coppings 2002)

which suggests that the door is the warmest area of a refrigerator, and the temperature there is often not cold enough to be a suitable location to store eggs. Many modern refrigerators have designed areas within the door for the storage of milk. Of the consumers in our study, 17% placed milk in the door while the majority, 58%, placed in on the top shelf. As with eggs, milk should not be stored in the door. Consumers should reserve the refrigerator door for soft drinks, various condiments, sauces, and other foods whose composition would resist microbial growth due to acidity, solute concentration, etc. Soft and hard cheeses were found in all areas of consumers' refrigerators, although a common location was the meat compartment. It is inappropriate to store cheeses in the meat compartment if stored there with uncooked meat.

In-Home Refrigerator Inspection

During the in-home refrigerator inspection conducted in Phase 2 of the study, it was noted that 44% of consumers had one or more raw meat or

poultry items in their refrigerators; 38% were found on the top or middle shelves, sites favoring cross-contamination. Twenty-two percent of these meat items were on the bottom shelves, 19% in the meat compartment, and, inexplicably, 17% in the vegetable bin. RTE meats (220 items) were located in all areas of the consumers' refrigerators, including the vegetable bin, with the greatest amounts on the middle shelf or in the meat compartment (30% and 29%, respectively). Sixteen percent of consumers had placed milk, and 25% eggs, in the door of their refrigerators, a location often too warm for proper food refrigeration, as discussed above. Researchers got the impression that the participants didn't know what was in their refrigerators with any certainty or how long the food had been there. It appeared commonplace for consumers to push food to the back of the refrigerator as more was put in, resulting in overfilling and increasing the potential for spoilage and possibly food-borne illness.

Between 15% and 29% of foods examined were found to be past the date appearing on the container (Table 8). While nearly all milk containers were dated, no date was found on a significant proportion

of the other foods, ranging as high as 49% of the raw meat or poultry items checked. Eggs are safe to use past the date found on the carton (FSIS 2003). Likewise, milk has a "Sell by" date appearing on the container and can be stored and consumed for several days past that date. Nonetheless, consumers were clearly storing and consuming a number of foods past the dates which appeared on containers, despite the fact that 82% of the consumers interviewed claimed that they routinely checked expiration dates on foods and 85% agreed that safety messages found on food containers were helpful.

Researchers judged that circumstances that might allow for cross-contamination existed in 41% of refrigerators examined (Table 9), while 26% had non-meat foods in the meat compartment with raw meat, another situation where cross-contamination could occur. Moreover, 33% contained unsealed or open containers leaving food unprotected, and cooking containers or serving bowls were found in 51% of refrigerators, indicating inappropriate handling of leftover food. Other minor concerns were noted as well.

Table 8. Summary of Food-Container Dates (%)*.

Food Item	Not past date	Past date	No date
Raw meat or poultry	32	19	49
RTE meats	62	15	23
Other RTE foods	63	18	19
Mayonnaise	55	29	16
Raw eggs	45	22	33
Fluid milk	82	17	1
Other dairy products	58	20	22

* Percent of consumers; N = 200.

Table 9. Problem Areas from Refrigerator Checklist.

Area of Interest	%*
Circumstances that might allow cross-contamination	41
Non-meat foods in meat compartment with meat	26
Cooking containers/serving bowls	51
Unsealed/open containers in refrigerator	33
Inappropriate food in butter keeper	28
Non-food items in refrigerator	35
Moldy, spoiled, or old food	27

* Percent of consumers; N = 200.

Conclusions

While many consumers were found to be applying several common-sense practices to protect cold foods during purchase and transport, use of coolers or other means to maintain temperature of cold foods was rare. Consumer knowledge of refrigeration temperatures was poor; their recognition of this fact and ability to effectively maintain control over food temperature was also lacking. Placement of foods within the refrigerator appeared nearly random and consequently many opportunities for cross-contamination exist in consumer refrigerators. Significant additional evidence of poor refrigeration practices was found, suggesting overall refrigeration and food-safety knowledge is poor, putting consumers at risk for food-borne illness.

Implications

The need for investigation of consumer food-handling practices and dissemination of appropriate food-safety information continues as consumer food-purchasing, handling and storage practices adapt to a rapidly changing global economy. Consistently worded storage messages are needed on food labels. Additionally, the provision by refrigerator manufacturers of built-in thermometers with clearly indicated temperature recommendations would be useful for consumers to monitor food-storage temperatures.

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