What's the "Deal" on Dented Canned Products – Are they Safe to Consume

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The views expressed in this paper are those of the author and do not necessarily reflect the official policy, position or views of BCIT, the Environmental Health Program of its faculty.

ABSTRACT

The following study was devised to determine whether dented cans should be sold in stores and if the refusal of dented cans from churches is a wise decision. The experimental procedures were set out to determine whether there is a significant difference in the proportions of contaminated cans to uncontaminated cans for two groups of dented cans and a group of non-dented cans. The pertaining legislation specifies to what extent a can should not be sold, however the extent of damage is usually at the discretion of an employee. Since the extent of damage could not be determined by the general public, this study looks at the type of damage. Two groups of dented cans were created to test if there is a difference in the likelihood of contamination between rim dents and body dents. A compression device was used to deliver a consistent force to each dented can. The forces at which the cans were subjected to were determined during a pilot study. The body and rim dented cans were subjected to 180 Newtons and 400 Newtons respectively. Two positive and two negative controls were made to test the microbiological component of this study. A total of 90 cans were tested for environmental organisms via the Pour Plate method. The results were statistically analyzed using the Chi-squared test. One out of 30 body dented cans showed the growth of microorganisms. In both the rim dented can group and the non-dented can group, no growth was found. The results of the study show that there is no association between dented and non-dented cans and the presence of environmental organisms as it reveals that the probability level of 0.363769 is greater than the set probability value of 0.05 and thus is not statistically significant.

This paper is dedicated to my family and friends for all the encouragement given.

Thanks to Vince Chiodo and Helen Heacock for all of the help and guidance provided, Mark Gendron for assisting with the physical aspect of the experiment, Kim Cummings and Ken Keilbart for all the support with the microbiological aspect of the experiment.

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INTRODUCTION

Canned products are visible in almost all grocery stores since a vast variety of foods such as vegetables, fruits, dairy, poultry, seafood and meats are canned (Denny & Blakistone, 1999). Instead of preparing a meal with fresh ingredients, canned goods are often used to supplement the ingredients or sometimes even the entire meal. With today's busy working force, consumers find themselves pressed for time before and after work thereby tempting many to resort to Ready-to-eat (RTE) meals, especially canned pasta or soups. These RTE meals require minimal time and effort to prepare where slight heating and serving is all that is necessary to satisfy a hungry family. Now that our society is more dependent on canned foods, it is of interest to look into the effects of dented cans. Most dented cans are salvageable but there are some that may pose a risk to the population.

Picture: Berean E-Newsletter. Retrieved on October 11, 2009 from http://www.berean-eagles.org/Newsletters/EN11_07.htm

History of Canning:

The concept of packaging foods for long time storage was first introduced in the 1800s by Nicholas Appert whom developed the idea of preserving food for the French soldiers in wine bottles and then subsequently heating the bottles in boiling water. English man, Peter Durand then elaborated on the idea by introducing a variety of materials that can be used for canning such as glass vessels, pottery, tin and other metals (Denny & Blakistone, 1999). The term canning was later associated with "tinned foods," but by definition the term canning means the method of preserving foods by the process of sealing fresh foods in a container that is then heated to a temperature that renders the food and container to be commercially sterile (Gavin &

Weddig, 1995). The container can be any material that can sustain the heat treatment and keep the food sterile. The process must be able to destroy all viable microorganisms and allow the product to be kept under normal conditions in non-refrigerated temperatures during storage and distribution (Gavin & Weddig, 1995; Denny & Blakistone, 1999). The process of canning foods allows producers to extend the shelf life of the product, by eliminating the presence of oxygen, preventing the growth of bacteria, yeast and mould, killing heat-labile organisms and creating a hermetic seal that locks the food in and keeps pathogens and other external environmental substances out (National Center for Home Food Preservation, 2009). Studies have shown that some canned goods may contain more nutrients than consuming the fresh product itself. Foods are usually canned immediately after harvest to preserve the freshness of the product (Klein, 1997; Denny & Blakistone, 1999; Canned Food Alliance, n.d.).

Concern of Microbial Contamination:

Once a can gets dented the question then becomes about the sterility of the can and whether it has been compromised. A dent may or may not affect the hermetic seal. If the seal is broken the negative pressure that was created during the vacuum seal process begins to drag in the environmental air that surrounds the can (Denny & Blakistone, 1999). The environmental air may contain organisms that are pathogenic. The food product may provide the minimal to optimal conditions for the organism to grow and reproduce. The broken seal allows oxygen into the can so that aerobic organisms can survive. Factors that affect the survival and growth of microorganisms are temperature, pH, nutrients, moisture, presence or absence of oxygen, and

Picture: Shutter Shock Images.
Retrieved on October 10, 2009 from
http://www.shutterstock.com/pic-29740660
-stock-photo-three-damaged-tin-cans.html

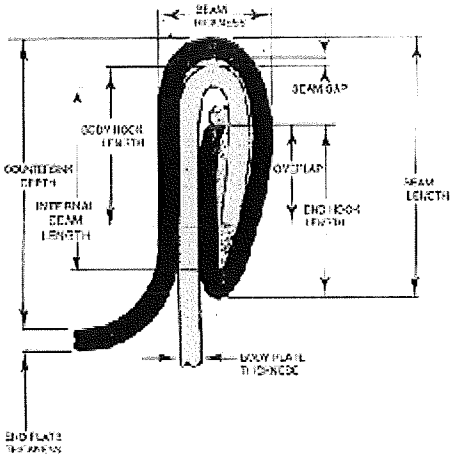
time (CFIA, 2009b). Moisture is measured by the amount of free available water to microorganisms, also known as the water activity content (Denny & Blakistone, 1999). The pH is measured by the acidity of the food. Foods such as canned tomatoes are highly acidic and thus create a harsher environment for microorganisms to survive in (CFIA, 2009b). Most foods that are exposed to the environment are regulated by one or more of these factors, for example deli meats are refrigerated and thus temperature is controlled. Breads and other baked goods do not have high water activity therefore are controlled by the absence of moisture. Damaged low-acidity canned products are of higher risk than higher acidity products because they provide all the favourable conditions for most microorganisms. The dented can containing low-acid products provides the optimal pH range above 4.6 and since the canned product remains on the shelves non-refrigerated, the temperature is in the danger zone (Denny & Blakistone, 1999). The canned product usually has nutrients and moisture that allow for growth. The time for which canned products can incubate the organism is variable, as most canned-goods do not have an expiry date and can stay on shelves for months to years (CFIA, 2009a). Now that the microorganisms can penetrate the barrier of a damaged can towards these favourable conditions, the presence of oxygen is the last factor required. The external aerobic environmental organisms surrounding the can could now invade and thrive in the newfound nutritious environment that contains oxygen. Since a damaged can could allow for oxygen and organisms to enter into the can simultaneously, there would be no more factors to control for spoilage by microorganisms (CFIA, 2009b).

Now imagine the following scenario:

As a worker stocks the shelves at a grocery store, he accidentally knocks over a row of canned goods. What does the worker do? Does he simply pick up the cans and reassemble the dented cans on the shelf or does he throw them out due to the possibility of a broken seal?

Packaging Requirements and Complying with the Regulations:

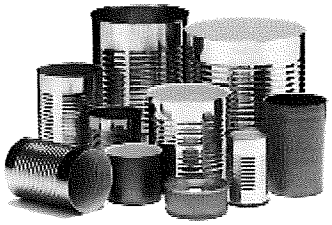
Canned-goods can become dented prior to filling, during processing, and post manufacturing, while storing, transporting or stocking. A survey showed that 1.03 percent of metal cans have an average level of damage (Charbonneau, 1994). This means that approximately 1 in 100 cans are damaged while at a manufacturer location. With so many opportunities for cans to get dented, we are fortunate in the sense that there are regulations specifying to what properties a damaged canned-good must not be sold. According the Food and Drugs Regulation, section B.27.003 states that "No person shall sell a low-acid food packaged in a hermetically sealed container where the container is swollen, not properly sealed, or has any defect that may adversely affect its hermetic seal." However, the general public does not know the difference between a body dent and a double seam dent. A body dent is a pronounced mechanical distortion of the metal container at the middle portion of the can that may or may not affect the side seam in a 3 piece can. A double seam dent is also known as a rim dent and is a pronounced mechanical distortion at the rim of the



Picture: Canadian Food Inspection Agency. Retrieved on October 10, 2009 from http://www.inspection.gc.ca/english/fssa/fispoi/man/canboi/chap2e.shtml

can where the double seam is located (CFIA, 2007). With this in mind, the cans that have a body dent are generally minor and do not affect the hermetic seal of the can and thus can be sold in stores. On the other hand, some major body dents can distort the metal enough to pull the metal on the double seam. This will reduce the metal available to complete the double seam thereby compromising the seal (Segal, 1992). Rim dents are more likely to affect the hermetic seal and therefore should not be sold. As one can see, the extent of damage is up to the employees' discretion.

LITERATURE REVIEW



Picture: Ball Packaging Americas. Retrieved on October 10, 2009 from http://www.ballamericas.com/page.jsp?page=26

Ball packaging is Canada's major can packaging provider. The company's Technical Services Manager, Paul Waldmiller (personal communication, October 7, 2009) stated that structural integrity of a dented can is "generally not at risk for subsequent failure," but if the can is "dented at the seam or is heavily impacted then the risk for spoilage is more significant." A canning industry can expect to find no more than 1 in 10,000 cans which are defective upon receiving from the can supplier (Karel & Lund, 2003). This rate decreases as a worker is assigned to check all the cans and lids for defects prior to filling the cans. The defective packaging materials are disposed (CFIA, 2007).

Many health programs have advised that a bulging or swollen can should not be used since the can may contain *Clostridium Botulinum*, a pathogen that produces gas in an oxygen free environment (CFIA, 2006). Rusted or heavily dented cans should also not be used as they may contain a small hole which allows for contaminant to enter (Trickette, 2001).

The main concern in the canning industry is the risk of harbouring a botulinal toxin, which is a heat-resistant toxin (Gavin & Weddig, 1995). This toxin causes paralysis and can lead to death (Hayes, 1983). The death of a Belgian man due to type E botulism led the 1982 investigation of the salmon canning industry. The FDA traced the source back to an Alaskan salmon packer. The investigation found that the Alaskan firm was reforming cans but the reforming machinery was faulty. The cans had come out torn and had tiny holes. The botulism poisoning was identified to be due to the defective can formation (Hayes, 1983). The seriousness of consuming food contained in a defective or damaged can is outlined in this investigation.

Another study was conducted in Texas on an incident where an outbreak occurred in a church due to the consumption of chilli. The chilli was purchased at a salvage store. The study found that 15 of the 24 church attendees whom consumed the chilli developed botulism. The salvage store accepted foods that were normally rejected by standard grocery stores. These foods included dented canned-goods, repackaged foods and foods that have expired. Investigators believe that food mishandling and improper storage of foods may have contributed to the foodborne illness outbreak (Kalluri et al., 2003). Situations like this one, poses the question of whether the sale of dented canned-goods should be allowed. The regulations imply that any obvious defects and damages that affect the sterility of the can are not to be sold. In addition, one can assume that a majorly dented can might affect the seal but what if a person, whom is deciding what extent of a dent affects the seal, does not take precaution or is unable to visibly see a sign of a compromised seal. This person would then be putting the public at risk but yet is still

following the regulations. The regulation does not state clearly what type of dent is allowed and what is not. It also does not state what extent of damage is considered saleable.

Picture: The Frugal Café. Retrieved on October 11, 2009 from http://www.frugal-cafe.com/freebies-cheapies/articles/bargain-bin-phoenix.html

Many grocery chains such as Albertson's and Discount Foods and More, sell dented canned-goods at a fraction of the price, this attracts thrifty shoppers that appreciate the price reduction (Yelp, 2009; Taragana, 2009). This economic tactic does not take into consideration the potential risk for public health. Instead due to financial benefits, companies are willing to sell dented cans. The ambiguity of whether there should be a reason to be worried will be investigated in the study.

Ironically, some churches and charity organizations that are in need of donations do not accept damaged goods, including dented cans. Due to liability issues the church does not want to be responsible for the possibility of causing a food borne illness to their members and attendees (American Red Cross, n.d.). Could this refusal of food be foolish, as the canned goods may have the same chance of being contaminated as non-dented cans. Since the government allows for dented cans to be sold in stores, this implies that most dented cans should be safe to consume so why are there organizations that would rather choose to have less food to serve to the unfortunate than to serve food from dented cans. The organization could always sort through the dented cans

if they do not trust the discretion of others and pull out any severely dented cans themselves. On another note there are people that will eat cans that are dented in their cupboards and pantries, but the same individuals will choose not to purchase a dented can from a grocery store. These peculiarities and choices are questioned for logicality in the discussion portion of this study. In addition, this experiment has investigated whether dented cans hold a statistical difference in the risk for contamination compared to non-dented cans.

PURPOSE OF STUDY

The purpose of this study is to determine whether canned-goods dented at the rim or the body has a significant difference in the sterility of the can so as to cause contamination. The null hypothesis of the experiment would be that there is no significant difference in the sterility of a dented canned good so as to cause contamination.

METHODS & MATERIALS

Materials and Equipment:

Quantity	Item	Description
96	cans of evaporated milk	Pacific Light Evaporated Milk 370mL
1	can opener	used to open the cans
94	Petri dishes	to hold the growth medium
94	Pipette tips	to dispense the milk aseptically
1	1000 µL pipette	to dispense the milk
2.1 liters	Aerobic plate count agar	growth media
1	scale	used to weigh the amount of powered agar
1	Graduated cylinder	to measure out the amount of distilled water to make the agar
1	Funnel	to funnel the agar powder into the flasks
3	1 L Erlenmeyer flasks	used to prepare the agar
21 mL	2,3,5-triphenyl tetrazolium chloride (TTC)	a pH indicator
1	TTC dispenser	used to dispense TTC
1	Filter sterilizing disk	to trap organisms that may be in the TTC

1	Box of Kleenex tissues	facial wipes to clean the cans with alcohol
1	Bottle of rubbing alcohol	to sanitize the cans
1	Wax pencil	used to label the petri dishes
1	Autoclave	to sterilize the agar
1	Autoclave glove	used to handle the autoclaved flasks
1	Waterbath	to cool the agar down to specific temperature
1	Incubator	used to incubate the plates
1	Plastic spoon	to stir soil into the milk for the positive control
1	Tinius Olsen Compression device	used to deliver a force to dent the cans
1	4 x 4 x 4 inch block of wood	to make the can holder
1	10 x 14 x 0.5 inch piece of wood	to make the can holder
4	Screws	to anchor the wooden pieces together
1	Hand drill	to anchor the wooden pieces together
1	Black marker	to label the cans

Standard Method Description:

Can Preparation

At the start of this experiment, 90 cans of evaporated milk were obtained from the same lot. Thirty cans were dented at the rim, another thirty were dented at the body, and the remaining thirty cans were left un-dented. The Tinius Olsen loading frame, which is a compressing device, was used to deliver a constant force to dent the cans (Tinius Olsen, 2008). Each can that was dented at the rim was subjected to a force of 400 Newtons. The cans that were dented at the body were subjected to a force of 180 Newtons. This amount of force to use was determined during the pilot study. A wooden support was made to hold the cans in place at the appropriate angle to be compressed. A 4 x 4 x 4 inch block of maple wood was cut from corner to corner at a 45 degree angle using a miter saw. The two pieces were placed side by side to form a 90 degree angle (Please refer to Appendix A for a diagram). The two pieces were then anchored to a 10 x 14 inch wooden board that is 0.5 inch thick.

Step 1) The first 30 cans were placed so that the rim of the top of the can was pointed upwards (Please refer to Appendix B for a diagram). All of these cans were labeled with an "R" and numbered from 1 to 30.

Step 2) The next 30 cans were placed so that the body of the can was pointed upwards. (Please refer to Appendix C for a diagram). All of these cans were labeled with a "B" and numbered from 1 to 30.

Step 3) The last 30 cans were labeled with an "N" and numbered from 1 to 30.

Step 4) Subsequently, all 90 cans were placed in an incubator set at 35 degrees Celsius for 5 weeks. (Please refer to the picture in Appendix D).

Agar Preparation

On the day of plating, 2.1 Litres of Aerobic Plate Count (APC) agar was prepared following the instructions on the bottle label. APC agar is a common media that can enumerate all organisms in a food with the process of dilutions (Food Technology, 2007). However, since the study only measured the presence or absence of organisms, dilutions were not carried out.

Step 1) 16.5 grams of APC agar powder were weighed out on a scale and placed into an Erlenmeyer flask using a funnel.

Step 2) 700mL of distilled water was added to the flask. This was done 3 times to make a total 2100mL of agar.

Step 3) The 3 flasks were swirled around until the agar powder dissolved. Thereafter the flasks were placed into the autoclave to be sterilized; the autoclave was set at 121 degrees Celsius for 15 minutes at a pressure of 15psi (AMSCO, 1991; Health Canada, 2006).

Step 4) After autoclaving the agar, the three flasks of agar were placed in a water bath set at 45 degrees Celsius. The water bath level was at least 1 inch from the top as suggested in the water

bath manual (LabLine Instruments Inc, n.d.). The agar was allowed to reach a temperature of 45 degrees Celsius before the addition of 2,3,5-triphenyltetrazolium chloride (TTC). For every 100mL of APC agar, 1mL of TTC is required (Difco Laboratories, 1998).

Step 5) 7mL of TTC was dispensed through a filter sterilizing disk into each of the Erlenmeyer flasks containing the agar. TTC is a pH indicator that will allow for one to see the color change in the presence of environmental organisms (Difco Laboratories, 1998).

Microbiological Plating Procedures

Step 1) Just prior to conducting the microbiological component of this study, the exterior of all 90 cans were wiped with individual alcohol sanitizer wipes. A pre-cleaned can opener was also sanitized using the alcohol wipes.

Step 2) Each can was opened using the can opener and 1mL of evaporated milk was transferred to a petri dish labeled in the same manner as was the can that the milk was taken from. (eg. N1).

Step 3) Immediately after, 12 to 15mL of the agar was poured into the petri dish. This was estimated by filling the petri dish ¾ full.

Step 4) Once all the cans were plated, they were allowed to gel before they were inverted and placed into the incubator set at 32 degrees Celsius for 48 hours. Refer to Appendix E for further instructions.

Every can was opened using the can opener just prior to being tested. Therefore before moving on to the next can, the previous can must have been plated and labeled appropriately. In between every can opening the can opener was wiped down with an individual alcohol wipe to ensure that no microorganisms from one sample were transferred to the next plate. In addition to that point, a new pipette tip was used for every can that was tested; this practice also prevented the cross-contamination of organisms to subsequent plates.

Controls

A positive and a negative control were prepared using 1 non-dented can of evaporated milk. Prior to opening the can, the exterior of the can was wiped with rubbing alcohol using a facial tissue. 1mL was aseptically transferred to a petri dish via a 1000μL pipette. The molten APC agar was then immediately poured into the petri dish. The cover was placed back onto the dish and the dish was swirled to disperse the milk with the agar. This plate was labeled as the negative control and inverted before it was placed into the incubator. This step was repeated once more to create two negative controls. Next, 1 gram of garden soil was stirred into the open can of milk using a plastic spoon. 1mL of soiled milk was transferred to a petridish where molten agar was subsequently poured. The dish was swirled with the cover on top. This plate was labeled as the positive control and inverted before it was placed into the incubator. This step was repeated once more to create two positive controls. After 48 hours both controls were taken out of the incubator and examined for characteristics.

Alternate methods:

The APC agar could be used in a solid state rather than in a molten state. This method is called the Surface or Spread Plate Method. The preparation of this agar would be identical up until the point where it is poured into the plates (Downes and Ito, 2001). Instead of pouring the agar on to the petri dishes already containing 1mL of milk, the agar is poured into an empty petri dish and allowed to solidify. Then 0.2mL of milk is dispersed on top of the agar and is spread with a spreader on an agar plate turn table.

Another type of media that could be used for microbiological testing is Tryptic Soy Broth (TSB). This media is prepared in glass tubes. The presence of organisms is shown through the

clarity of the media. A cloudy substance at the bottom of a TSB tube implies that there are organisms in the tube. A clear medium in the tube implies that there are no organisms in the media. This method then requires that each tube is subsequently streaked out on to an APC agar (Food Technology, 2007).

As an alternative to using the Tinius Olsen compression device, the cans could be dented by dropping them each at a consistent height. The laws of physics state that the force at which an object hits the ground is constant if allowed to fall freely from a constant height. This is due to Newton's law of gravity (Giancoli, 2000). However this method will result in a varied denting location, so many cans may be needed to satisfy the statistical component of this experiment.

Justification of chosen method:

The use of a two piece can instead of a 3 piece can creates one less factor to worry about. In a 3 piece can there is a side seam on the body of the can. This seam would need to be accounted for when positioning the can to be dented so that the compression device does or does not compress a portion of the side seam. The labels of every can would need to be removed so that the experimenter could see where the side seam was located.

Pacific Evaporated Milk was chosen because it was a low-acid product that was in the form of a liquid. A pure liquid consistency is easier to work with as it eliminates the need to stomach any solid components. The liquid can be easily transferred to a petri dish using a pipette. The pipette tips do not have to be cut using a flamed inoculating loop. The process of making the hole of the pipette tips larger creates another potential source of error. The need to stomach 90

samples would take a significant amount of extra time thus a liquid product is more efficient. The reason why evaporated milk was chosen over other liquid products was due to its characteristics. Milk goes bad quickly and hence signs of spoilage can be determined easily. Other products usually contain a lot of sodium which makes it harder for organisms to grow (Net Industries, 2009). Due to the limited amount of time available to complete this experiment, milk was the best choice. There were many brands of evaporated milk and any brand would suffice, however Saputo Pacific Light was on sale and was purchased due to financial limitations.

The experimenter decided to use the Tinius Olsen compressing device instead of dropping the cans at a specified height so that the locations of the dents were controlled. Both methods deliver a consistent force but the latter is more prone for error since the height at which the cans must be dropped has to be carefully measured and repeated. Dropping the cans at a high height would also be very dangerous to anyone that might walk by the landing area.

The molten form of the Aerobic Plate Count Agar was preferred because the use of TSB and APC agar was a redundant process and the use of sold APC agar required more technical skill in spreading the milk smoothly on to the solid agar. Though the solid agar method would allow for more time flexibility since the plates can be prepared in advance and placed into the refrigerator for months, the simplicity of the molten agar method has a reduced potential for contamination. This is due to the need for agar exposure when spreading the milk in the solid agar method.

Reliability and Validity

The reliability and validity of this experiment was taken into consideration when planning and designing the experiment. All cans are of the same size, type and brand. They were purchased from the same lot to minimize variation in the product. The reproducibility of the study has been addressed such that each can is dented in the same manner with the same device. This ensures that the cans are dented in the same location and with a consistent force. In addition a pilot test was done to confirm that the compression device worked and that an optimal force was applied to each group of cans. According to the Compendium of Methods for the Microbiological Examination of Foods, the Pour Plate method for the microbiological component is a standard method. This ensures the reliability of the study. To increase both the validity and reliability of the results, the maximum number of cans will be tested for each group with regards to financial and time constraints. For statistical purposes, this number was found to be 30 cans for each group. An impact loading device would produce a dent that is more comparable to what would be seen in a grocery store. Most cans fall off the shelves and are subjected to an impact load from the floor. Due to the inability to acquire an impact loading device, a static loading device was used. The validity of the experiment is dependent on the criterion. Since the criterion of the study was set to compare the location of a dent and whether contamination has occurred, it is not important as to how the cans became dented but rather that they were dented in the same manner. The APC growth media is appropriate for the determination of environmental organisms as it provides a nutrient rich medium and is free of organisms. The TTC that is added to the agar allows one to see a color change in the presence of organism thus the growth of organisms can be directly measured. Furthermore, all samples will be tested using aseptic techniques. These applications address the validity of the study.

The positive and negative controls were made in advance to test the microbiological section of this experiment. These tests verified that the chosen method used for the study would work. (Please refer to the pictures in Appendix F).

Inclusion and exclusion criteria:

This experiment can apply to any low acid (pH above 4.6) canned food product in a two-piece metal can (Downes and Ito, 2001). However, only Saputo Pacific Light evaporated milk was included. Exclusion: Any high acid canned food products (pH below 4.6) and/or any canned products in a 3-piece can.

Pilot study:

A pilot study was conducted to test the optimal force at which the cans should be subjected to. Three cans from the same lot were emptied by drilling two holes into the bottom of the can near the center. This was done to prevent leakage due to accidental operations. The Tinius Olsen loading frame device was used to deliver a consistent force to the cans. The cans were rotated four times to use other parts of the rim. Once the force was comparable to what was seen on the shelves of grocery stores, the force was recorded and tested on one emptied non-dented can. After that, the force was tested on one final non-emptied non-dented can. The same procedure was done to determine the force to dent the can at the body. The forces to be delivered to create body dents and rim dents were determined to be 180 and 400 Newtons respectively.

RESULTS AND STATISTICAL ANALYSIS

Descriptive Statistics:

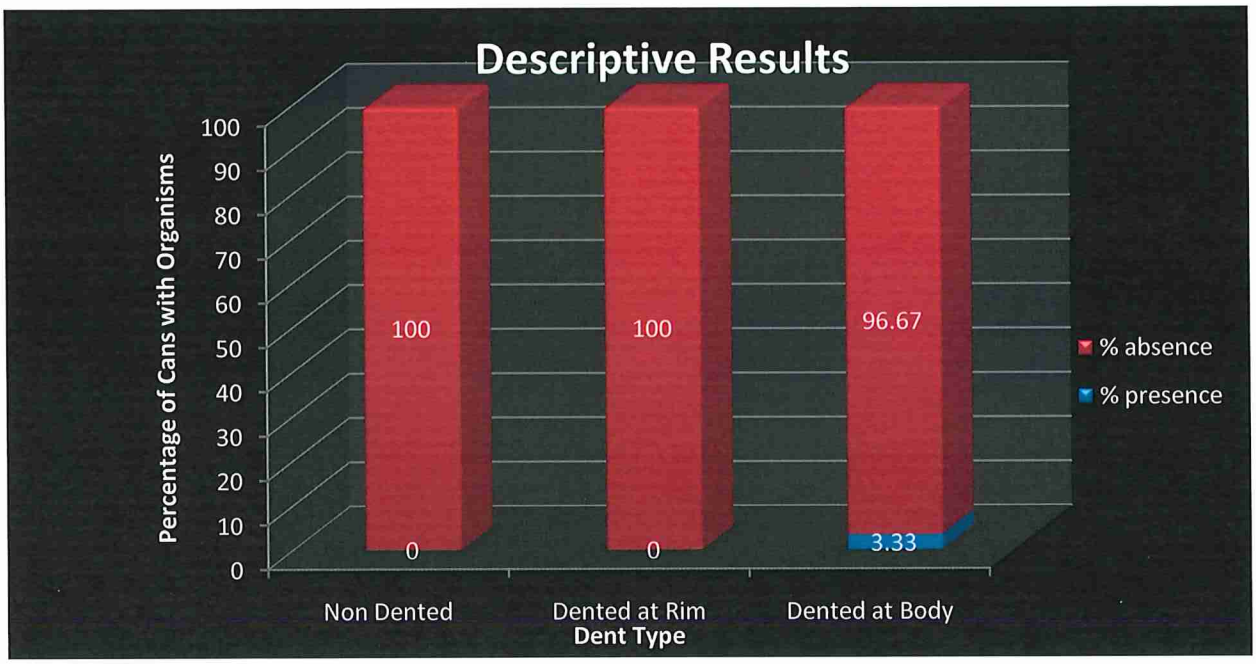
The design of this study looked at the presence or absence of microbial contamination in two groups of dented cans and a group of non-dented cans. Since nominal data was collected, the mean, mode, median, ranges and standard deviations could not be collected. Instead the proportion of cans that were contaminated in each test group are described.

Descriptive results:

The percentage of cans that showed a presence of organisms for the non-dented, dented at the rim, and dented at the body were 0%, 0%, and 3.33% respectively. The relative percentages are displayed in the bar graph below.

Table 1: Raw data

	# Presence	# Absence	% Presence	% Absence
Non Dented	0	30	0	100
Dented at Rim	0	30	0	100
Dented at Body	1	29	3.33	96.67



Inferential Statistics:

As mentioned earlier the presence or absence of environmental organisms was observed. This results in the collection of nominal data thus the Chi-Squared test was chosen for the statistical analysis component of this research study. Microsoft Excel was used to create the data entry spread sheet which can be found in Appendix G. The data was then entered into a statistics software called NCSS. The software was used to manipulate the data so that the three groups could be compared amongst each other. The tabulated statistics reports from NCSS can be found in Appendix H. The following hypotheses were tested.

H_0: There is no association between dented and non-dented cans and the presence of environmental organisms

H_a: There is an association between dented and non-dented cans and the presence of environmental organisms

Inferential Results:

The expected quantity of dented cans that did not contain organisms was tabulated to be 29.7 cans out of 30. Thus the expected number of dented cans that showed a presence of organisms is 0.3 out of 30. The experimental data was reported in a 2 x 3 table which provided a degree of freedom value of 2. The probability of exceeding the Chi-squared critical value was set at 0.05. Together, these values determine the critical Chi-squared to be 5.991 (Zar, 1999). The calculated Chi-squared of 2.022472 did not exceed the critical Chi-squared and thus accepts the null hypothesis. The probability level was found to be 0.363769 and is greater than the set probability value of 0.05, meaning that there is no association between dented and non-dented cans and the presences of environmental organisms. According to Helen Heacock (personal communication, November 9, 2009), Chi-squared tests do not have power and there are no non-parametric equivalents for it. The NCSS statistics program does not provide alpha and beta errors.

Errors:

A possible error that may have occurred during this study is called the beta error. It refers to the chance that the results from this study are inaccurate due to sampling from an insufficient sample size. A beta error is when one accepts the null hypothesis of no difference when in reality there is statistical difference. To minimize the chance of a beta error, the sample size must be increased. The larger the sample size, the lower the chance of a beta error occurring (Heacock and Chiodo, 2008).

DISCUSSIONS

Observations were made 24 hours after plating and 48 hours after plating. (Please refer to the picture in Appendix I). All plates showed the absence of organisms 24 hours after plating. However, after 48 hours, a small number of plates showed a few red dots, but after confirmation with Kim Cummings (Lab Instructor) those plates were the results of environmental air getting on the plates during the pipetting of the milk and pouring of the agar. The majority of the contamination occurs during the first few hours after a can has been dented. This happens when the vacuum is broken and begins to draw in air as there is negative pressure in the can. If the environmental organisms had entered the milk cans during the denting stage, the petri plate should show a major color change to red indicating a vast growth of organisms.

The data in Table 1 indicates there was only one plate with significant color change out of 90 plates. The color change from white to red showed that the milk from the can labeled with B6 was contaminated with environmental organisms. (Please refer to the picture in Appendix J) The B6 petri dish had milk taken from the B6 can which was from the body dent group. According to Appendix F there is no association between dented and non-dented cans and the presence of environmental organisms as it reveals that the probability level of 0.363769 is greater than the set probability value of 0.05 and thus is not statistically significant. Both B5 and B7 petri dishes had no presence of organisms thus reaffirms the aseptic technique of the experiment.

Both the non-dented can group and the rim dented can group showed no presence of environmental organisms in any of the petri dishes. This leads to the notion that a typical rim dented can is as safe to consume as a non-dented can.

With the knowledge that rim dents have a higher chance at compromising the hermetic seal, it was surprising to find that there were more contaminations found in body dented cans rather than rim dented cans. These findings suggest that a typical body dent is more severe than a typical rim dent. However, due to limitations of the experiment the results may be different if a larger sample size was available. The body dented can group showed 1 in 30 cans being contaminated with environmental organisms. This is equivalent to 33,333 cans in a million dented cans. Taking everything into consideration, the findings warrants further testing of dented cans.

According to Health Canada, dented canned goods are allowed to be sold in stores but the Canadian Food Inspection Agency suggests that one should not purchase any dented canned goods (CFIA, 2006). The results from this study support their decision since the data is not statistically significant enough to suggest a health hazard but contamination was still determined in a dented can group.

Churches and other donation organizations may be doing the right thing by refusing dented canned goods for liability reasons, but the option of consuming dented canned goods should be given to the people that are most in need of food. For instance a homeless person may suffer from starvation, or may eat food from the garbage in desperation. They are already taking a chance of contamination when the food is from the garbage therefore they should be given the choice to consume food from a dented can (Feldma, 2007). Many pathogens may harbor in garbage thus food from a garbage bin may have a higher chance of contamination than from a dented can (Pablo, 2007). Prior to giving the dented canned food, the person receiving the food should be educated in the potential risks. In addition, as a safety precaution the church could always heat the food from dented cans to 74°C to ensure that all microorganisms are killed,

although the heat-stable toxins and spores will not be destroyed (Heymann, 2008). Regardless of the different approaches, the decisions made by some donation organizations are understood in the sense that they are trying to help and protect the public.

LIMITATIONS

Since this study was conducted as part of the BCIT requirement for the Degree of Bachelor of Technology in Environmental Health, a time constraint was placed to complete this study and a budget of one hundred dollars was allotted. For statistical purposes, 30 cans was the minimal sample size for each group. Therefore due to time and financial constraints the number of cans that were feasibly testable was limited to 90 cans.

RECOMMENDATIONS

- The findings support the view of health officials in the sense that there is no hard evidence linking the presence of microorganisms to dented cans but there is concern. The policies in place are sufficient for the time being.
- Until further testing can be done, retail stores should still be allowed to sell dented cans, however more education should be provided to the stores that sell dented cans on the safety of dented cans.
- The potential risks should be outlined to consumers in the form of pamphlet or other media sources.
- Churches and other donation organizations should give the consumer an easy to read pamphlet on the safety of dented cans or verbally explain to them about the risks involved prior to giving out any dented can product.

Future Studies

- Upon completion of this study, the results suggest that the experiment should be redone with larger sample sizes.
- However branching horizontally, the experiment may be altered so that the extent of the damage may be tested. For instance, applying different forces onto each can group so that one could determine at what force a can has been subjected to will compromise the sterility of the can.
- Another future study may be to measure for the presence of spores and molds since some molds were observed on a few plates during this study.
- The extra variable of a 3-piece can will also modify the experiment.
- The same experiment done using a high acid canned product would be another possible study.

CONCLUSION

The completion of this experiment shows that the results accepts H_0 and conclude that there is no statistically significant association between the location of a dent on a can and the presence of environmental organisms. Although this conclusion is true for this study, one petri dish containing milk from a body dented can was found to show a significant presence of organisms. This may infer that further testing is required to show the true correlation between dented cans and presence of environmental organisms.

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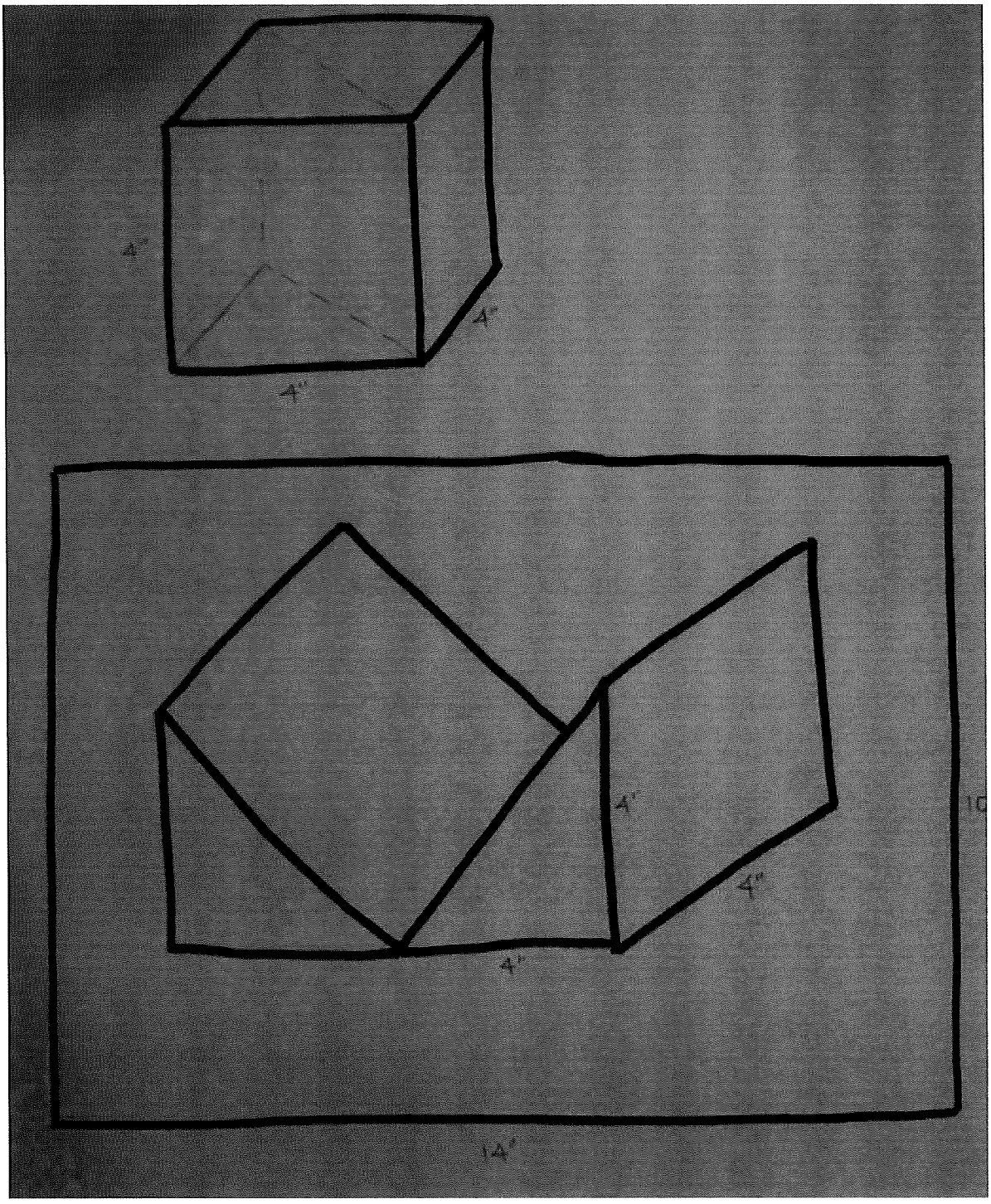
APPENDIX A



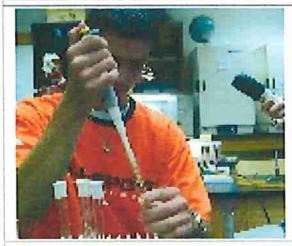
APPENDIX B

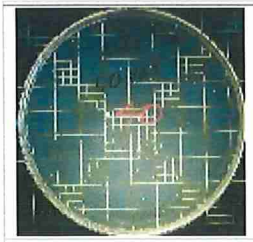
APPENDIX C

APPENDIX D

APPENDIX E

POUR PLATE TECHNIQUE:

	1. Label the bottom of the empty sterile plates
	**2. Obtain sample through the use of a pipette**
	**3. Inoculate labeled empty petri dish** with the sample
	4. **Pour 15 mL of melted Plate Count Agar** (45° C) into the inoculated petri dish.
	5. **Cover and mix thoroughly by gentle tilting and swirling the dish.** Do not slop the agar over the edge of the petri dish.
	6. Cover and place on a flat surface undisturbed for about 10 minutes to **allow the agar to *completely* gel**. In this illustration, the agar is completely gelled and the surface is "smooth as glass."
	**7. Invert and incubate** at 32° C for 24-48 hours.

	**8. Observe and record findings.** (absence or presence)

Pictures retrieved from
http://biology.clc.uc.edu/fankhauser/Labs/Microbiology/Meat_Milk/Pour_Plate.htm

APPENDIX F


TRACIE CHEUNG
(-)ve Control
Nov 25, 09
TRACIE CHEUNG
(-)ve Control
Nov 25, 09


TRACIE
CHEUNG
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Tracie Cheung
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Nov 25, 09

APPENDIX G

Measure of Organisms	Type of Dent: Non Dented	Dented at Rim	Dented at Body
Absence	30	30	29
Presence	0	0	1

	Measure of Organisms	Type of Dent
1	Absence	Non-Dented
2	Absence	Non-Dented
3	Absence	Non-Dented
4	Absence	Non-Dented
5	Absence	Non-Dented
6	Absence	Non-Dented
7	Absence	Non-Dented
8	Absence	Non-Dented
9	Absence	Non-Dented
10	Absence	Non-Dented
11	Absence	Non-Dented
12	Absence	Non-Dented
13	Absence	Non-Dented
14	Absence	Non-Dented
15	Absence	Non-Dented
16	Absence	Non-Dented
17	Absence	Non-Dented
18	Absence	Non-Dented
19	Absence	Non-Dented
20	Absence	Non-Dented
21	Absence	Non-Dented
22	Absence	Non-Dented
23	Absence	Non-Dented
24	Absence	Non-Dented
25	Absence	Non-Dented
26	Absence	Non-Dented
27	Absence	Non-Dented
28	Absence	Non-Dented
29	Absence	Non-Dented
30	Absence	Non-Dented
31	Absence	Dented at Rim
32	Absence	Dented at Rim

33	Absence	Dented at Rim
34	Absence	Dented at Rim
35	Absence	Dented at Rim
36	Absence	Dented at Rim
37	Absence	Dented at Rim
38	Absence	Dented at Rim
39	Absence	Dented at Rim
40	Absence	Dented at Rim
41	Absence	Dented at Rim
42	Absence	Dented at Rim
43	Absence	Dented at Rim
44	Absence	Dented at Rim
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58	Absence	Dented at Rim
59	Absence	Dented at Rim
60	Absence	Dented at Rim
61	Absence	Dented at Body
62	Absence	Dented at Body
63	Absence	Dented at Body
64	Absence	Dented at Body
65	Absence	Dented at Body
66	Absence	Dented at Body
67	Absence	Dented at Body
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73	Absence	Dented at Body

74	Absence	Dented at Body
75	Absence	Dented at Body
76	Absence	Dented at Body
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78	Absence	Dented at Body
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80	Absence	Dented at Body
81	Absence	Dented at Body
82	Absence	Dented at Body
83	Absence	Dented at Body
84	Absence	Dented at Body
85	Absence	Dented at Body
86	Absence	Dented at Body
87	Absence	Dented at Body
88	Absence	Dented at Body
89	Absence	Dented at Body
90	Presence	Dented at Body

APPENDIX H

Cross Tabulation Report

Page/Date/Time 1 20/01/2010 4:54:13 PM
Database

Counts Section

Measure of Organisms	Type of Dent			
	Dented at Body	Dented at Rim	Non-Dented	Total
Absence	29	30	30	89
Presence	1	0	0	1
Total	30	30	30	90

The number of rows with at least one missing value is 0

Expected Counts Assuming Independence Section

Measure of Organisms	Type of Dent			
	Dented at Body	Dented at Rim	Non-Dented	Total
Absence	29.7	29.7	29.7	89.0
Presence	0.3	0.3	0.3	1.0
Total	30.0	30.0	30.0	90.0

The number of rows with at least one missing value is 0

Chi-Square Statistics Section

Chi-Square	2.022472	
Degrees of Freedom	2	
Probability Level	0.363769	Accept H0

WARNING: At least one cell had an expected value less than 5.

APPENDIX I

APPENDIX J