

## **SECTION I INTRODUCTION**

### *Problem Statement*

Like many entrepreneurs, the creators of Nude Food have made numerous sacrifices, dedicated countless hours, and have shown endless passion and belief in their product. Entrepreneurs Doug Margel, and Scott and Stacy Grimm, should be proud of the work they have accomplished thus far with the resources at hand. The demand for Nude Food nutrition bars is steadily growing throughout Colorado and is only going to increase. A handful of local health food stores cannot keep the bars on their shelves for more than a week, yoga studios and hotel lobbies are asking to be restocked weekly, and the local television station is begging for an interview with the start-up company. However, Nude Food is unfortunately unprepared for the popularity. Their problem is that they cannot keep up with the rising demand with only six helpful hands.

The researcher, Chelsey Wood, has decided to collaborate with this entrepreneurial company because she too has a passion for nutrition and believes in the Nude Food products. Almost four years ago, Chelsey was diagnosed with Celiac Disease and has had to adopt a gluten-free lifestyle. She no longer consumes food products that contain wheat, barley, rye, or oats in order to prevent painful stomach sickness and to sustain a healthy digestive system. Finding new gluten-free products like the Nude Food bars is always exciting because Chelsey does not feel so limited on such a restrictive diet. People with this particular food allergy, like the researcher of this project, and other health conscious consumers, are the target market in which the three entrepreneurs are trying to reach. It has been fairly convenient to target these consumers because thousands of physically active, health conscious tourists inundate Colorado's mountainous regions every winter and summer to enjoy the beautiful outdoors. Whether they are skiing, hiking, or cycling in the mountains many of these physically active customers choose to

snack on nutrition bars similar to Nude Food bars because they do not only conveniently fit in backpacks or pockets, but replenish the body with essential nutrients and energy.

### *Needs*

To create a new package for the Nude Food nutrition bars, there are three important needs that must be evaluated; moisture barrier properties, durability, and environmental impact.

Moisture Barrier Properties play a crucial role in protecting the food product from reaching ideal conditions for spoilage and pathogenic organisms. Knowing the pH level, the measurement of acidity in the product, and the available water ( $A_w$ ), the moisture content within the product, can be extremely helpful when choosing the appropriate moisture barrier material.

The pH (acidity) of a food can affect both flavors and shelf life. An acidified food has a pH below 4.6 and an alkaline food will have a pH above 4.6. An acidified food must be thermally processed and since the Nude Food bars are not thermally processed, they must contain a pH of greater than 4.6. With this in mind the creators of the Nude Food bars must take caution because according to Gould (2001) most molds do grow between pH levels 4.5 and 6.8 which is within the desired pH range for the bars.

Water activity or available water ( $A_w$ ) refers to the moisture content within the product that is not bound to other molecules. Gould (2001) also says that it is not the total water in the product, but rather the water molecules available to harbor the growth of microbiological contaminants. Water activity can range from a level of zero to one, one representing pure water. If a food product has a low  $A_w$  number such as 0.50, it has less likelihood of sustaining mold or microbes (see Figure I). Therefore, the lower the  $A_w$  in a food product, the more likely it is to have a longer shelf life.

Unfortunately, the entrepreneurs of the Nude Food bars currently do not have the appropriate funds to seek professional assistance in retrieving pH and  $A_w$  levels for their products. This critical knowledge is unknown to the researcher at the time of research and an appropriate estimation, with additional knowledge from her technical advisor Keith Vorst, will be used for the purpose of the project. Due to the product's raw ingredients and the moist touch

when physically handling the bars, it is safe to conclude for packaging purposes that the Nude Food products have a relatively high water activity. Based on this conclusion a high moisture barrier for the new package will be appropriate in controlling pre-existing moisture and preventing additional moisture from entering the wrapper.

The durability of a product is also a very important factor to consider when developing a new package. The package should withstand the manufacturing and distribution environment, as well as the consumer's lifestyle. The package needs to be able to protect the product from the manufacturing line until reaching the shelves of the retail store, preferably in a state that a consumer finds adequate. However, the lifecycle of the packaged product does not end on the retail shelves. It continues further into the hands of the consumer where it is then going to experience rough transportation conditions in a backpack, fanny pack, purse, or tight and cramped quarters of a pocket. With the proper implementation of a sufficient heat seal on each end of the package, the product is more prone to containment during the forces it encounters along its journey.

Not only does the new Nude Food bar package need to withstand rugged transportation environments, but it also needs to keep intact at Colorado's higher altitudes. Pressure testing will take place in the Plastics Lab (building 21 –Room 133) on California Polytechnic State University's (Cal Poly's) campus in San Luis Obispo, California to determine the package's ability to endure changes in altitude while simultaneously maintaining its form and function.

In the article *Food Packaging and Its Environmental Impact*, author Kenneth Marsh notes "food packaging is a noteworthy contributor to Municipal Solid Waste (MSW) because food is the only product class typically consumed three times per day by virtually every person. Accordingly, food packaging accounts for almost two-thirds of total packaging waste by volume." The founders of Nude Food recognize the extent of waste that packaging contributes to the landfills and have asked Chelsey to reduce the amount of material for the new package. Unfortunately, laminate films used for various nutrition bars on the market today are not recyclable with traditional recycling systems. Due to their multiple material layers, recycling machines have a hard time separating the layers individually. This process is too advanced for

current recycling centers and the appropriate machinery is quite expensive. However, when recycled correctly, the packaging film could possibly be reused for other applications.

### *Background or Related Work*

In 2003 Adrian Mateo, a former Industrial Technology student, analyzed the packaging of *Cliff Bar* bars for his senior project. Like the entrepreneurs of Nude Food, the founders of *Cliff Bar Company* wanted to know if it was feasible for the company to reduce the amount of packaging material used to wrap their bars. Luckily Adrian was able to have access to a lab and professional help for determining the pH and Aw for *Cliff Bar and Company* so that he could make a decision on whether or not *Cliff Bar* would be able to reduce the thickness of their packaging film.

### *Potential Solutions*

Similar to Adrian Mateo's senior project, Chelsey is also analyzing the packaging of a company's nutrition/energy bar and searching for a more sustainable package. However, this project differs slightly from Adrian's project because Chelsey is actually in search for a new packaging material for the Nude Food bars. At present Nude Food company is manually packaging their bars in a thick multilayered coffee bean-like package that is heat sealed on one edge and opened on the other. To close the open end, the entrepreneurs roll the excess material, then tape it shut. Chelsey's design idea for the new package is to reduce the film thickness, minimizing the current waste in material, and efficiently heat-seal both ends of the new wrapper as close to the product as possible, eliminating any unnecessary, excess material. Once the new film has been received, she will then be packaging the product on a special food packaging machine located in the Cal Poly Food Science Pilot Plant, followed pressure testing the wrappers she has created.

### *Contribution*

With a thinner and more accurately fitting package, Nude Food will be spending less money on packaging material and decreasing the amount of film being thrown into landfills. And by eventually incorporating an automated machine into their packaging process, there will be no need in the future for long, tedious hours of packaging and labeling each bar by hand. At a faster

automated production rate Nude Food will finally be able to save physical energy, spend more time on other aspects of the business, keep up with the rising demand for their products, and begin taking larger orders to start building a more satisfying profit.

## **SECTION II**

### **REVIEW OF LTERATURE**

The purpose of this project is to design and integrate a new flexible package for the Nude Food nutrition bars. It is important to perform a literature search to obtain a wider knowledge and understanding of the food packaging industry. With a better comprehension of the food science world, more accurate and beneficial results can be drawn for conclusion. The following research is broken down into the important functions of a package, the laws and safety of the food packaging industry, and details of the current product.

#### *Packaging:*

The Packaging Industry, according to The Flexible Packaging Association (FPA 2008), is a \$135 billion industry and continually growing each year. Many people do not realize the importance of a package and the role it plays throughout their lives. Essentially there is a package for almost any application one can think of and each package can serve a different purpose from the next. A package can contain, protect, and transport a product while also informing and attracting consumers at the same time. No matter what the function of the package might be, it is crucial that a product is placed in a package before entering its distribution system.

#### *Containment*

From the moment a product receives a package it is expected that the item inside the carrier will be contained until reaching the consumer's hands. This is the role of the primary package as it directly holds the contents inside and intact.

#### *Protection*

There are times when a package will arrive at its destination contained, yet it is in a worse state than it originally started before it entered the distribution cycle. It is more than likely that during

the transportation or storage of the product it encountered physical abuse or a harsh environmental atmosphere. Not only is it an important role of a package to protect against physical forces such as shock, vibration, and compression, but also spoilage from unwanted germs, dust, moisture, etc. Millions of dollars in the United States are lost each year due to inefficient protective packaging. A package can also protect against theft and tampering with help from tough seals and materials that are difficult to penetrate through.

### *Transportation*

There can be many stops along a product's distribution route before reaching its final destination. For instance, a product may be transported from the manufacturing facility to a warehouse, and then taken to a retailer, and then finally into the customer's ownership. But transportation might not stop there. Even the consumer could have his or her own additional transportation agenda for the product. The transportation role of a package is very critical as it allows a product to get from one place to another.

### *Attraction*

Once a product is placed on the shelves, racks, or floor of a store it is then the function of a package to attract a consumer's attention. This can be done with creative packaging that stands out from the other packages on display. Many companies will use an array of colors, shapes, designs, and even brand names for their packaging to intrigue consumers. The goal is to capture a shopper's attention and then lure them in to pick up the product and observe it more closely. As soon as the merchandise is in hand, the consumer is more likely to purchase what he or she is holding.

### *Information*

When the product is in possession of the consumer, it is important that the package informs the user for his or her protection and knowledge. The amount of required information that should be displayed on the package depends on the severity of different laws and regulations of certain agencies. Yet it is more beneficial to the consumer when they have access to information such as ingredients, nutritional facts, directions, warnings, and contact information.

## Food Packaging:

It is difficult to walk into a grocery store today and not find a food product in some kind of package. Packaging is needed to keep food fresh and protected from contamination and is vital for providing safe and edible foods to consumers. Over 200 laws and regulations are enforced by the United States Food and Drug Administration (FDA) to also ensure the safety of food for the American people. With a collaboration of laws, safe food processing practices, and effective food packaging, consumers can have a better chance to experience the flavors, smells, and different textures of food from all different parts of the United States.

## *The FDA*

It is an enforcement agency that regulates all food in the United States with the exception of meat and poultry, and in some certain instances, can actually regulate these products as well (Vieira,1999). Their primary goal is to minimize the potential occurrence of food borne illness outbreaks and ensure fair trade to the consumer based on labeling information by enforcing the Federal Food Drug and Cosmetic Act as well as the Fair Packaging and Labeling Act. FDA certification can be important for any company large or small, however, a food processing company is required by law to abide by all applicable regulations established in the Code of Federal Regulation (CFR) if;

- 1) Gross sales exceed \$500,000.00 annually
- 2) Sale of product extend beyond the state lines of manufacture
- 3) Sales are conducted on-line

## *The Colorado Department of Agriculture*

Considering that Nude Food is a start-up company whose annual gross sales do not exceed \$500,000.00, sale of product does not extend beyond Colorado state lines, and sales are not conducted on-line, they are not legally obligated to become FDA certified. Regardless of whether a company is FDA certified, the State in which the food processing company manufactures product will have its own regulations independent of those set forth by the FDA. Some regulations will be similar, others less stringent. The purpose is to protect individual consumers by implementing food safety standards. Annual inspections by the state agency will determine whether regulatory compliance is met and the company is allowed to operate and sell



within their state. Colorado Department of Agriculture must approve any facility before production begins and can be asked to walk through before a lease is signed.

### *Influences of Food Safety*

Food safety practices should be a high priority in facilities to avoid food borne illness. Recently there has been an ongoing outbreak of Salmonella Typhimurium in the United States. Luckily the FDA has been able to trace the Salmonella back to a peanut processing plant in Georgia. According to FDA (2009), the Peanut Corporation of America, PCA, has recalled a number of their ingredients from the market due to violations of FDA requirements. As mentioned on the FDA website “More than 2,100 products in 17 categories have been voluntarily recalled by more than 200 companies, and the list continues to grow,” as the PCA files for bankruptcy. Underestimating the importance of food safety can unfortunately lead to fatalities to both consumers and businesses. Author Parker Waichman Alonso of the article *Peanut Salmonella Outbreak Could Continue for Years* writes that the salmonella outbreak has potential to last for a few more years since there are a high number of products made with PCA ingredients and the tainted foods could possibly stay in circulation.

### *GMP's and SOP's*

Aside from FDA regulations a company should have their own GMP's and SOP's. GMP's are Good Manufacturing Processes and their aim is to prevent adulteration. The definition of adulteration is food “which has been prepared, packed, or held under insanitary conditions where it may have become contaminated with filth or rendered injurious to health” (Vieira, 1999). SOP's are standard operating Procedures and are a specific set of instructions to conduct any particular operation. All SOP's should be kept on file to show a local or FDA inspector and updated regularly. There are several purposes of a specific set of tasks; to eliminate variability, to have any employee be able to conduct the operation, and to show inspectors that the necessary steps are being taken in every action to prevent contamination of food borne illness.

### *The Fair Packaging and Labeling Act*

Many consumers in the past and in some instances still are today misled by fraudulent and incorrect information stated on packaging labels. The Fair Packaging and Labeling Act of 1966

was passed to ensure that consumers have the correct and appropriate information on packaging in order to avoid confusion as to what he or she will be purchasing. It is a United States law that applies to labeling on all consumer commodities. This act requires a label to provide the identity of a product, the name and place of the business of the manufacturer, packer, or distributor, and the net quantity of the contents. The Fair Packaging and Labeling Act not only protects the consumer, but can also allow them to make suitable purchasing decisions against competing products.

The Product:

#### *Description*

Nude Food nutrition bars were created in the beautiful mountains of Carbondale, Colorado by founder Doug Margel. His passion for nutrition and health motivate him to create and produce energy bars that nearly everyone can enjoy, especially those with food allergies. The goal of his innovative food bar is to obtain pure nutrition with the help from raw and organic ingredients. Packed with proteins and crafted to deliver sustained energy, Doug and his partners Scott and Stacy Grimm, have been gradually grabbing the attention of the “health conscious” locals of Carbondale, Marble, and Aspen, Colorado. And the locals continue to demand for more.

#### *The Current Package*

As of now, the entrepreneurs of Nude Food wrap parchment paper around each 3.4oz bar and manually stuff these gourmet snacks into a 4.2 mil, expensive, white, narrow, coffee bean-like bag (see Figures II and III). This package is currently priced at \$0.08 a bag and is a rapidly growing expense for the small start-up company. These pouches arrive at the production site with a heat sealed bottom, back seal, and open top. Once the product is slipped into the flexible package the open end is folded two or three times then taped shut. Labels can either be slapped on by hand after or before filling the pouch.

#### *Distribution Cycle and Requirements for the Package*

When the bars are contained in their coffee bean-like packages, they are stacked into a box and transported to a room where they sit and wait to be assigned to a delivery destination. Since there is a strong and steady demand for these new energy bars, the packaged snacks only stay in

storage a few days, maybe a couple weeks at maximum. Once they are delivered to a retailer, it is anticipated that the Nude Food bars will be snatched from the retail shelves in less than a week.

### *Shelf Life*

Due to a lack of funds, Nude Food has not been able to receive an official shelf life test for each nutrition bar flavor at this point in time. Olds, et.al. (2004) defines shelf life of a product as “the time during which the quality of the product remains acceptable to the consumer.” By knowing the shelf life of a food or beverage product the quality has a better chance of improving and the appropriate, cost effective packaging material can be selected. Unofficial testing of the Chai Ginger Chip Nude Food bar took place at the Cal Poly Food Science Lab only to obtain rough figures so that an appropriate decision on packaging materials could be made. These tests are in no way legally binding or official. Although it is of high recommendation that official shelf life testing for the Nude Food bars becomes a top priority for the start-up company in order to guarantee that their products are safe to consume.

Once accurate measurements of shelf life have been obtained, the packaging label must include a stamp or indicator of what the “best if used by” date would be. At a minimum, it is incorporated into a lot number for reference and printed onto the label. If it is determined, for example, that the shelf life is one year and the product is produced on January 1, 2009 then the lot number would include the numbers 01.01.2010 telling the consumer it is best if used by that date or simply a “best by” date independent of the lot number. Using the lot number system is a beneficial practice for traceability if need be in the future.

As previously mentioned, Aw and pH levels are critical factors that influence shelf life of a product. Olds, et.al. (2004) also writes that microbiological load, certain types of fats and oils, and nutrients with sensitivity to pH, heat, moisture, and light can be limiting factors of shelf life as well. Since the researcher of this project unfortunately has limited knowledge in food science and the necessary facility and equipment are not available, shelf life testing will not be performed and will not be a critical factor discussed when choosing new packaging material for

this project. However, shelf life plays a critical role in food packaging and should not be ignored when making future packaging decisions.

### **SECTION III**

### **SOLUTION**

The purpose of this project is to find a new packaging solution for Nude Food's nutrition bars. It is important for the researcher to evaluate different packaging options before making a final decision. In this section each possible packaging alternative will be included with a description of the material, followed by two or three positive and negative attributes. Three potential packaging solutions have been chosen and are analyzed below.

#### *Packaging Option I*

The first alternative packaging solution is a multilayer stand-up pouch (SUP) with a top re-sealable zip-lock closure (see Figure V). This particular package is constructed with two heat seals on each lateral side of the pouch and a bottom gusset that allows the product to stand upright on retail and home shelves. SUP packaging has become increasingly popular in retail stores due to its ability to maximize shelf space and tastefully display products at the same time. These packages come in an assortment of sizes, colors and materials. Common SUP designs are either made from a multilayer metalized film, a plastic multilayer translucent film, or a blend of the two. The packaging pouch with a combination of the two different films contains a metalized backside, to help preserve the food inside, and a clear plastic film on the front side that acts as a window for customers to view the product. Stand-up packages are used for a variety of products ranging from fertilizers to liquids and are also available to purchase with a pouring spout or a one-way air valve to keep products fresh. However, these additional features do increase the price of the package and the owners of Nude Food prefer to keep the packaging expenses to a minimum. If SUP's are chosen for the new packaging, Nude Food bars would be placed inside the pouch, stacked one on top of the other, without individual wrapping.

### *Advantages*

The first advantage of using a stand-up pouch for packaging the Nude Food bars is that a multiple amount of bars would be packaged into one single container. This eliminates excess individual wrapping and makes it more convenient for the consumer to retrieve a bar from their pantry or shelf. Often consumers spend time rummaging around the kitchen trying to find an individually wrapped snack that could be, for example, hiding behind other food on a shelf or under additional snacks in a kitchen drawer. Another benefit for choosing a stand-up package is that the re-sealable closure at the top of the pouch provides the consumer with the option to reuse the package for storing other foods once the entire original product has been consumed. This is not possible when the snacks are individually packaged because once the wrapper is opened it can no longer be used and is then thrown into the trash. Reusing the SUP makes this a more sustainable packaging alternative compared to the current Nude Food bar package.

### *Disadvantages*

One problem foreseen in choosing a stand-up pouch is that because Nude Food bars are moist, due to the different nut oils used, there is a concern that the bars would end up sticking to one another. This could cause a consumer frustration and prevent the customer from purchasing the product again. Since Nude Food bars would not be individually wrapped in a stand-up pouch this could lead to a second downfall. Due to the product's oily texture, a consumer would be unable to grab a bar from the pouch and place it into a backpack or purse to eat later. This could result to the consumer's personal belongings getting oil on them and the wasteful need of having to use an additional bag or napkin to prevent the bar from potentially damaging the consumer's possessions. The final disadvantage of choosing to use a SUP is that this particular package is more expensive than wrapping the bars individually. On average, a stand up package can cost \$0.30 per pouch which is six times the cost of an individual wrapper. This price is more than the entrepreneurs of Nude Food are willing and financially able to spend on packaging materials.

### *Packaging Option II (A and B)*

Packaging option II, both A and B use the concept of individually packaging each Nude Food bar (See Figures VI and VII). Compared to the current Nude Food package and the stand-up pouch, the individual packaging will have a thinner gauge, or less thick, film. This packaging

option is more sustainable in the long run because it uses less material which results in less waste being produced in landfills. Package A and B each have a flexible “pillow-pouch” design and can conform to the shape of the product efficiently. This light-weight, condensed package permits the consumer to conveniently transport and store the product. Both packaging ideas, A and B, are constructed of multilayer films, also known as laminates, yet each film has a different combination of materials that make up its layered structure. Package A is made from a clear plastic laminate whereas Package B is formed with a metalized laminate.

#### *Advantages of Packaging Option II (A)*

The biggest benefit that Package A has over Package B is that the clear film allows the consumer to see what the product looks like before he or she decides to make a purchase. There are many energy/nutrition bars on the market today and a majority of the packaging does not contain a translucent film. Therefore the products that can be seen through the packaging film have somewhat of an advantage over the other bars on the retail shelf because customers don't have to spend a large amount of time looking at the ingredients of the bar. All the customer has to do is look through the clear package and, for instance, decide if he or she thinks a particular bar has too many nuts or not enough sesame seeds. It is truly more intriguing and convenient for the consumer to visually see which ingredients and how much of each is in a particular bar instead of reading the back label. Another advantage with clear laminate packaging is that it tends to cost less than a metalized film.

#### *Disadvantages*

One problem with having a clear film package is that it is not going to have the proper oxygen and moisture barrier properties that the Nude Food bars will need. Oxygen will be able to pass through the film and lower the bar's shelf life by promoting unwanted bacteria growth. Translucent packaging also allows light exposure which, according to Vieira (1999), can unfortunately make food spoil at a faster rate and undergo changes in color, flavor, and nutrient composition.

### *Advantages of Packaging Option II (B)*

Unlike the plain, clear plastic packaging films, metalized films offer excellent oxygen and moisture barrier properties (See Table I). They do the best job in maintaining the quality of a product and extending a food product's shelf life. As cited in Troedel (1986) this is because film with a metalized layer has "superior light-screening characteristics" that reduce the occurrence of rancidity. Metalized films also have excellent antistatic properties that reduce the amount of dust pick-up when sitting on retail shelves, making the package look more appealing towards consumers. Another advantage of choosing a metalized film is the high gloss and bright color capability when printing labels. This is an extremely attractive characteristic of the metalized films because a company wants their package to stand out from all the other products on the retail shelf and be able to capture the eye of the consumer.

### *Disadvantages*

The biggest downfall with metalized film is that it is more expensive than the clear plastic films. This is expected considering that the price of metal is, in general, more costly than plastic. An additional problem with metalized laminates is their opacity. It is definitely more appealing to a customer when they can view the product through the package so that he or she has a rough idea of what the snack might taste like. Selke (1997) writes that "Techniques exist for confining the metallization to certain areas of the film, so that transparent strips are produced." However, this process is also very pricey and would not be an appropriate financial decision for a start-up company.



## **SECTION IV**

### **RESULTS**

The goal of this project is to develop a new package for Doug Margel's Nude Food energy bars. Three alternative packaging solutions have been chosen and analyzed in the previous section. In the following section, the three potential packaging designs have been given a score (1-5), based on how well each design meets the specific needs of the project (See Table II). As stated in the beginning, moisture barrier properties, durability, and environmental impact, are three very important needs that the new Nude Food package must meet. The researcher has explained below her reasoning for each score given to all three packaging solutions. Afterwards, she seeks outside assistance to help her find the appropriate material for wrapping the bars. As soon as the material is received, the researcher creates thirty prototypes of the new package and uses a pressure tester to measure the strength of each prototype.

#### *Packaging Option I*

The stand up pouch received the second highest score due to its strong durability, yet the moisture barrier properties and environmental impact do not meet the researcher's expectations. She is worried that the bag would be left open or the re-sealable zip lock closure would not be shut properly by the consumer. This could lead to excess oxygen and water vapor exposure and cause the product to spoil at an extremely rapid rate, not giving the customer the time to enjoy and finish eating the bars. And although the stand-up pouch can be reused by the consumer, it is not recyclable. Compared to package A and B it uses five times the amount of material which also means a larger carbon footprint out of the three packing options and more waste in landfills.

#### *Packaging Option II (A)*

The clear, plastic, pillow-pouch package scored the lowest because of its low moisture barrier properties. Without a metalized layer in the film structure, the energy bar would not stay fresh

due to the oxygen and water vapor permeability through the film. Even though this film does make package A the most “environmentally friendly” option, due to the least amount of material being used, it does not effectively protect and prolong the shelf life of the product.

#### *Packaging Option II (B)*

This metalized film package meets all the needs of the new package. It has the best moisture barrier, uses less material than the current Nude Food package, and is well balanced between durability and flexibility. This is the packaging design the researcher has chosen to implement into the operations of the Nude Food bars.

#### *Seeking Outside Assistance*

As a result of the researcher of this project having limited knowledge of food packaging, she has decided to consult with an expert on stand-up pouches and multilayer films in order to find the best possible packaging material for Nude Food bars. Her goal is to obtain a donated sample of metalized film and then use it to create approximately 30 mock-ups of the new package. Each package will then undergo a pressure test done in the California Polytechnic State University Plastics Lab to finalize the project.

The expert the researcher has chosen to consult with is Project and Order Manager Nathan Bauer of Maxim Flexpac. Maxim Flexpac is located in Irvine, California and Nathan has found packaging solutions for other snack companies located in California including *Clifbar and Company* and *Think Thin Products*. His expertise and advice will be beneficial to the researcher as she selects a metalized film for the Nude Food bars.

Once the researcher’s thoughts and the product’s needs were discussed with Nathan Bauer, the current Nude Food package was sent to his facility in Irvine to be evaluated. From there, Nathan selected a new metalized film that best fit the new Nude Food package criteria. The specifications of the chosen film are listed below and interpreted in the following section.

*Film Specifications:*

**80 OPP/ Adhesive/48 MET-PET/Adhesive/100 CPP**

The top layer of the film is made out of an 80 gauge Oriented Polypropylene (OPP). Oriented Polypropylene is a flexible material derived from melting and stretching the polymer polypropylene. By orienting polypropylene, its physical properties are improved. It becomes a better water vapor barrier, stiffer, and has enhanced optics. The next layer is an adhesive coating that binds the OPP layer with a 48 gauge Metalized Polyethylene Terephthalate (PET) layer. Metalized PET is known to provide excellent oxygen barrier properties and offers important visual characteristics including bright shine and superior printability to prevent scuffing and rub off. The fourth layer of the film is a second adhesive coat that connects the Metalized PET material with the bottom layer of the laminate. The base of the film is comprised of a 100 gauge Cast Polypropylene (CPP) layer. Cast Polypropylene is commonly used as a heat seal layer, along with an OPP, for packaging food articles. In the packaging industry, CPP has been known to have high gloss potential, great transparency properties, superior sealing strength, and even high barrier properties.

*Producing Prototypes*

As soon as the donated material was received from Nathan, the researcher presented the roll of metalized film to her technical advisor, Dr. Keith Vorst, and together they scheduled a time to use the Horizontal Flow Wrap Machine (See Figures VIII, IX, and X). This piece of equipment is located in the California Polytechnic State University Food Science Lab and is used by students enrolled in one of Keith Vorst's advanced packaging classes. Unfortunately, the researcher had no prior experience in operating the machinery and hours were spent looking through direction manuals and fidgeting with various parts of the wrapping equipment. Dr. Vorst also dedicated an hour or two in trying to assemble the film correctly onto the packaging apparatus and finally came to the conclusion that the donated film was not wide and long enough to wrap the bars efficiently and continuously. The contingency plan was put into action.

### *The Contingency Plan*

Due to the metalized film not functioning accordingly with the Horizontal Flow Wrap Machine, Dr. Vorst told the researcher that she needed to create 30 bar wrapper prototypes by hand. This procedure was executed in the Cal Poly Plastics Lab with a single table-top heat sealer. To create a horizontal pillow-pouch wrapper, which imitates a Snickers® package, the following steps were taken:

- 1) Vertically fold an approximate 6 ½’’ x 5 ¼’’ piece of film, aligning corners
- 2) Heat seal where the two sides of the film come together. This creates the back seal.  
\*The top and bottom of package should be open
- 3) Heat seal the bottom end.
- 4) Fill the package with product and heat seal the top end. This will enclose the product.
- 5) Cut off excess material that extends past seal.

These five steps were repeated until 30 wrappers were constructed. A visual of the prototype is provided (See Figures XI and XII) and a tangible prototype is included in the orange senior project envelope.

### *Disadvantages of the Contingency Plan*

While manually constructing the new Nude Food packaging prototypes, the researcher encountered discouraging inefficiencies. The first problem was the inconsistent sealing performance of the heat sealer. No matter how many different heat settings the researcher experimented with, the machine never made the same seal consecutively. The heat bar was either too hot and left a jagged burnt seal, or not warm enough to thoroughly bind the multilayer film together. Another inconsistency was the size of the snacks themselves. Since the Nude Food bars are also assembled manually, the size and shape of the rectangular snacks are not uniform. Therefore, the exact amount of film could not be used to construct each wrapper. Having to customize every package was time consuming and inefficient. The last factor that contributed to variability was not being able to use industrial cutting equipment. The researcher was forced to cut the metalized film with a pair of hand scissors, unfortunately generating more inconsistency to the project.

### *Pressure Testing*

The last step of the project was to perform a pressure test on each of the thirty prototypes (See Figures XIII, XIV, and XV). Yet before the pressure test was conducted, each package had to undergo a leak test. This consisted of submerging a package one at a time for five seconds under water and carefully observing the seals of the package. If any bubbles were found continuously forming at the seal of the wrapper, this indicated a leak and the package could not withstand the following pressure test. Unfortunately the majority (twenty-three) of the wrappers showed signs of leakage right when they were submerged into the water. The leaking was due to the insufficient heat sealing machine that was used to bind the packaging.

Even though only seven packages had adequate seals, overall, this design was successful since six out of the seven functioning prototypes passed the pressure test (See Figure XVI and Table III). This test was performed to assess the strength and effectiveness of the seals at a specific pressure. The pressure of the machine was set to 10,000 feet to simulate the average altitude of Colorado, the hometown of the Nude Food Company (See Figure XIV). If the researcher had had the correct equipment to execute the appropriate wrapping procedure, the results of the prototyping and testing would have been more desirable.

## **SECTION V CONCLUSION**

### *Summary*

Doug Margel, the founder of Nude Food, approached the researcher, Chelsey Wood, one day at the Packaging Expo in Chicago and asked her if she would be willing to help him create a new package for his raw, gluten free, and dairy free energy bars. Without hesitation Chelsey took the opportunity to apply her packaging knowledge and assist Doug in improving his current packaging. As soon as Doug's existing package and production process were analyzed, Chelsey started assessing the needs of a new package. She concluded that the new package would need to have superior moisture barrier properties, considerable durability, and low environmental impact. Once the needs of the new package were established, Chelsey began researching potential packaging solutions to Doug Margel's problem.

Finally, the researcher narrowed the possible solutions down to three designs, Package Option I and Package Option II (A and B). In order to decide which package would best fit the needs of the project, the researcher evaluated all advantages and disadvantages of each packaging option and also scored each design (on a scale of 1-5) on its ability to satisfy all three needs of the package. As soon as the highest score was revealed, Chelsey decided to choose a pillow-pouch packaging design constructed with a metalized multilayer film.

The next step of the project was the most time consuming. Chelsey spent months trying to find a film company that would be willing to donate a roll of metalized film in order for her to be able to create prototypes. Fortunately she was able to talk with Nathan Bauer from Maxim Flexpac who helped her analyze the current Nude Food package and assisted her in choosing a metalized laminate that best suited her needs for the new package.

After the film arrived from Nathan, Chelsey made an appointment with Dr. Vorst and tried using the Horizontal Flow Wrap Machine in the Cal Poly Food Science Pilot Plant.

Unluckily the film did not fit properly on that specific piece of equipment and the researcher was forced to construct prototypes manually in the Cal Poly Plastics Lab instead. When all thirty prototypes were completed by hand, Chelsey returned the following week to finish the remaining step of the project.

The last objective for the Nude Food project was to perform a pressure test to all thirty of the prototypes. However, this was not feasible since twenty-three prototypes did not pass the prior leak test. This was due to the seals of the packages not being sealed efficiently. Unfortunately, the heat sealer that was used could not create efficient, uniform seals. On the other hand, six out of the seven prototypes that passed the leak test, passed the pressure test as well. If the heat sealer machine had produced more consistent, uniform seals, the results of the leak test and pressure test would have been more desirable. But for the six prototypes that survived both the leak test and the pressure test, this showed that the pillow-pouch design of the package combined with the durability of the metalized film, would be an appropriate alternative packaging solution for the Nude Food bars, assuming the company had efficient equipment.

#### *What was learned?*

After Chelsey has completed the Nude Food project, she looks back and cannot believe how time consuming the overall project turned out to be. In the beginning, she was more than excited to start working with the Nude Food Company. But as time passed, she began hitting many large bumps in the road, which are explained in the following section, slowing down her progress tremendously. She thought her work would never be complete.

Chelsey also learned that when working with a start-up company, resources are not always going to be as readily available as they would be with a more established business. Since Nude Food is still young, the company was and still is trying to launch their product with a very low budget. No legal food testing has been done to the bars which made it extremely difficult when trying to choose the appropriate material for a new package. The water activity, pH, and microbial count of a product are crucial elements to know when deciding on the proper food package. For this project the worst case scenario was assumed when determining the packaging material so that there would be little to no chance of the product reaching rancidity.

The researcher also admits that when she was trying to find a company to donate material for her prototypes she was not showing enough persistence. During hard economic times she discovered that persistency was the key to getting the results she wanted and needed. Numerous hours were spent making phone calls, writing hand letters, and sending emails asking for help.

### *Problems*

There were actually numerous problems the researcher encountered. The first was the fact that the Nude Food Company was located in Colorado. This made it difficult to communicate with Doug Margel and his team and physically show them the progress that the researcher was making.

The next struggle was finding a company that would assist the researcher with finding a metalized film and donating a roll of material that would be used to construct prototypes. The researcher was not anticipating that this step of the project would get her so behind so quickly. Sending out persistent emails and letters on official Cal Poly stationary was not enough to find a company willing to donate his or her film and also time to help. The researcher should have thought about this outcome beforehand, and possibly tried a different approach, considering the current recession that the economy was facing.

Another problem was the donated roll of metalized film not fitting the Horizontal Flow Wrap Machine properly. This cost the researcher even more time as she was forced to make prototypes by hand. There was no uniformity in this manual method and it lead to undesirable leak testing results. If the researcher had used a more modernized, efficient heat sealing machine to construct the prototypes, her results would have been superior.

### *Future Work*

Now that the researcher has provided Nude Food with a new alternative packaging solution for their energy bars, it is Doug Margel's decision whether or not he wants the company to start implementing the new packaging into his operation. If he does decide that he wants to switch to a pillow-pouch design for the Nude Food bars' packaging, he is going to need to invest in automated equipment such as a table-top Horizontal Flow Wrap Machine. This machine will be expensive, yet will save him the trouble and hours spent on manually packing the snacks.



However, if Doug wants to cut down on the cost of having to buy an expensive machine and rent a building to produce his snacks in, the researcher suggests that he find a local co-packing company. This company can make and package the Nude Food bars without adding additional stress to Doug and more fixed costs to his operation. Once Doug and his team determine where they want to continue processing the bars, Chelsey strongly suggests that Nude Food invest in certified food laboratory tests in order to one day find the perfect efficient packaging material. There are local universities in the Colorado region that do provide these certified tests.

### *Facets of the Project*

Even though the project took longer than the researcher expected, all three needs of the package were met. The new alternative pillow-pouch packaging solution has superior moisture barrier properties, a perfect balance between durability and flexibility, and uses less material which contributes to a lower environmental impact than the current Nude Food package. This packaging structure is more efficient because it conforms to the product better, meaning less wasted head space and again, less material being used. This pillow-pouch design creates a tight seal that also minimizes the chance of rancidity to occur on the product. A heat seal is ten times more protective than taping a package shut. Due to the thinner material being used in the new packaging solution, consumers will be able to open the package with more ease and discard the lesser amount of packaging waste into the environment. Overall, this less expensive, pillow-pouch packaging design constructed from a metalized film will drastically benefit Doug Margel and his Nude Food team.

## SECTION VI REFERENCES

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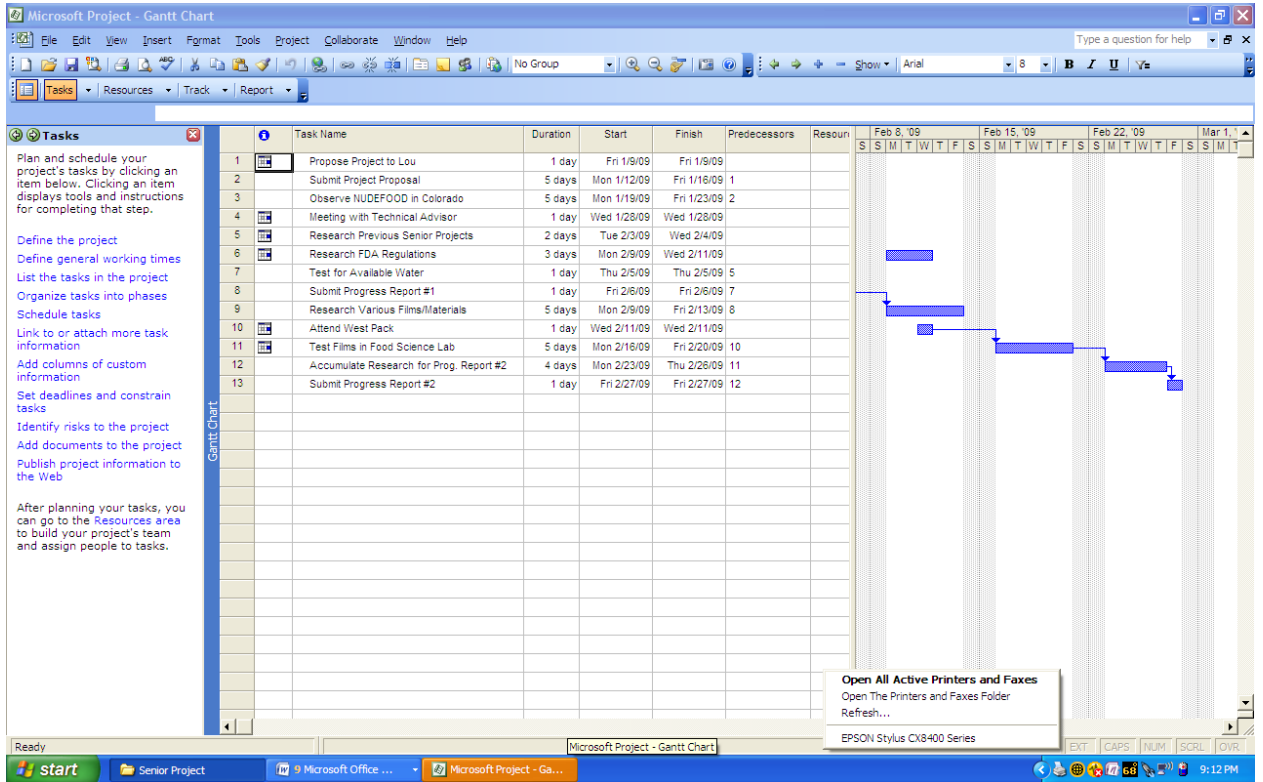
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<http://www.yourlawyer.com/articles/read/16137>.

## **APPENDIX**

# A. GANTT CHART



# FIGURE 1

## "Water Activity of Some Foods and Susceptibility to Spoilage by Microorganisms"

Adapted from Beuchat (1981)

$a_w$	Microorganisms generally <b>inhibited</b> by $a_w$ at this point	Examples of foods within this range of water activity.
0.950	<i>Pseudomonas</i> , <i>Escherichia</i> , <i>Proteus</i> , <i>Shigella</i> , <i>Klebsiella</i> , <i>Bacillus</i> , <i>Clostridium perfringens</i> , some yeasts	Highly perishable foods (fresh and canned fruits, vegetables, meat, fish) and milk; cooked sausages and breads; foods containing up to 4oz (w/w) sucrose or 7%NaCl
0.910	<i>Salmonella</i> , <i>Vibrio parahaemolyticus</i> , <i>C. botulinum</i> , <i>Serratia</i> , <i>Lactobacillus</i> , <i>Pediococcus</i> , some molds, <i>Rhodotorula</i> , <i>Pichia</i>	Some cheese (Cheddar, Swiss, Muenster, Provolone); cured meat (ham); some fruit juice concentrates; foods containing 55% (w/w) sucrose or 12%NaCl
0.870	Many yeasts ( <i>Candida</i> , <i>Torulopsis</i> , <i>Hansenula</i> ), <i>Micrococcus</i>	Fermented sausage (salami); sponge cakes; dry cheese; margaring; foods containing 65% (w/w) sucrose (saturated) or 15%NaCl
0.800	Most molds (mycotoxigenic penicillia), <i>Staphylococcus aureus</i> , most <i>Saccharomyces (baillii) spp.</i> , <i>Debaryomyces</i>	Most fruit juice concentrates; sweetened condensed milk; chocolate syrup; maple and fruit syrups; flour; rice; pulses containing 15-17% moisture; fruit cake; country style ham; fondants; high-sugar cakes
0.750	Most halophilic bacteria, mycotoxigenic aspergilli	Jam, marmalade; marzipan; galcé fruits; some marshmallows
0.650	Xerophilic molds ( <i>Aspergillus chevalieri</i> , <i>A. Candidus</i> , <i>Wallemia sebi</i> ), <i>Saccharomyces bisporus</i>	Rolled oats containing ~10% moisture; grained nougats; fudge marshmallows; jelly; molasses; raw cane sugar; some dried fruits; nuts
0.600	Osmophilic yeasts ( <i>Saccharomyces rouxii</i> ), few molds ( <i>Aspergillus echinulatus</i> , <i>Monascus bisporus</i> )	Dried fruits containing 15-20% moisture; some toffees and caramels; honey
0.500	No microbial proliferation	Noodles, spaghetti, etc. containing ~12% moisture; spices containing ~10% moisture
0.400		Whole egg powder containing ~5% moisture
0.300		Cookies, crackers, bread crusts, etc. containing 3-5% moisture
0.030		Whole mild powder containing 2-3% moisture; dried vegetables containing ~5% moisture; corn flakes containing ~5% moisture; dehydrated soups; some cookies and crackers

[http://marangonilab.ca/works\\_pages/amarango/file/-%20Chart%20of%20microorganism%20growth%20and%20water%20activity.pdf](http://marangonilab.ca/works_pages/amarango/file/-%20Chart%20of%20microorganism%20growth%20and%20water%20activity.pdf)

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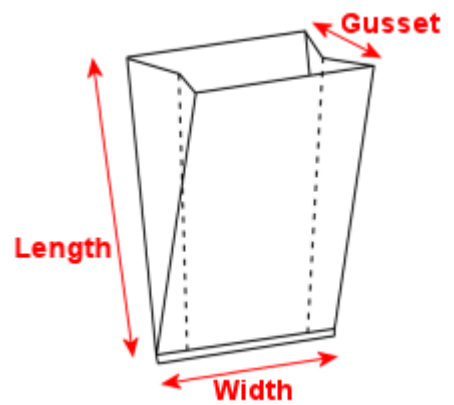
# Current Situation

FIGURE II



<http://www.savonbags.zoovy.com/>

FIGURE III



<http://www.thepackagingstore.co.uk/images/gusset.gif>

FIGURE IV

NUDE FOOD BARS



# Possible Packaging Solutions



← FIGURE V (OPTION I)



← FIGURE VI (OPTION II A)



← FIGURE VII (OPTION II B)

# Horizontal Flow Wrap Machine



FIGURE VIII

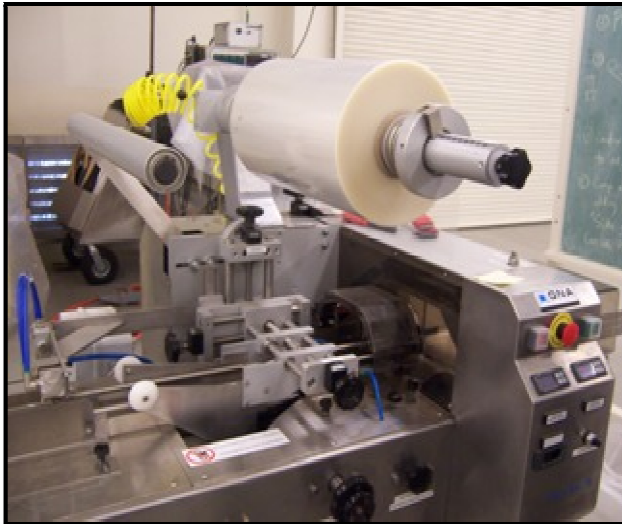


FIGURE IX



FIGURE X



# Prototype

FIGURE XI (Front View)

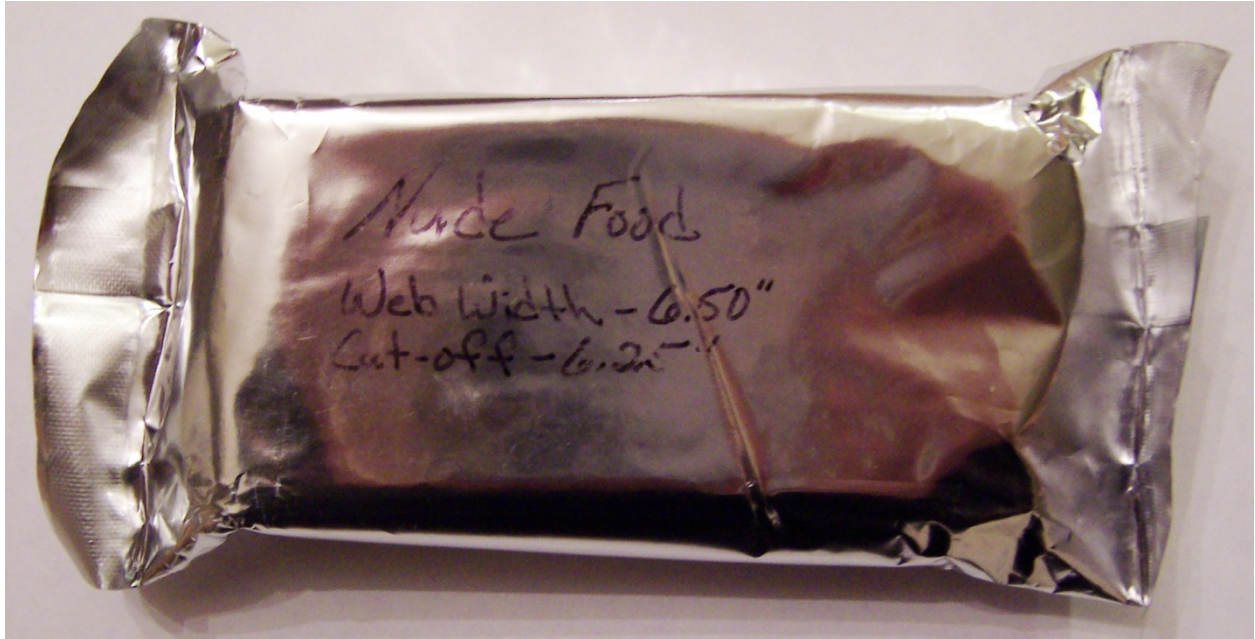


FIGURE XII (Back View)



# Pressure Testing

FIGURE XIII

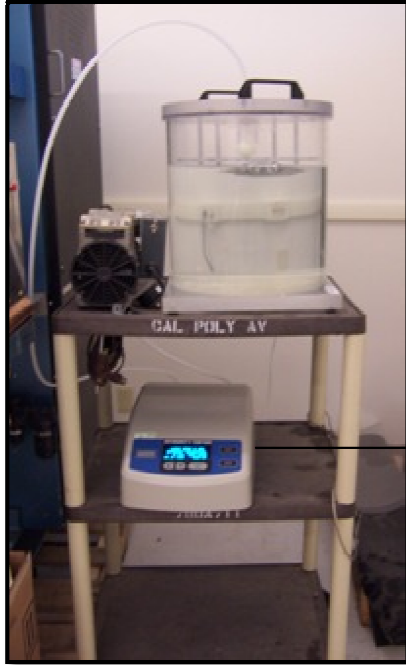


FIGURE XIV

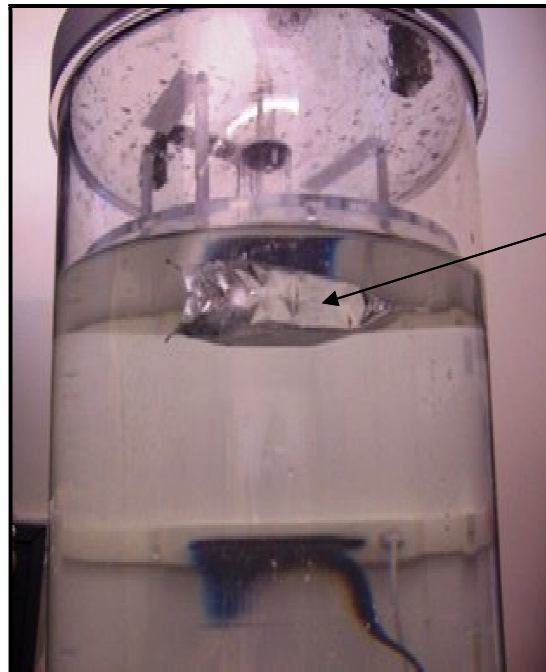
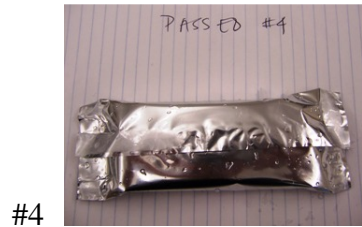


FIGURE XV

Product

# FIGURE XVI

## Passed



## Failed



# TABLE I

## Oxygen and Water Vapor Permeability Data-Metalized Films vs. Plain Films

\*Oxygen and water vapor permeability's data are compared in the following table and graphic which show the advantages of metalized films compared with plain films, considering oxygen and water permeability.

PRODUCT	THICKNESS ( $\mu$ )	OXYGEN (cc/m <sup>2</sup> /24 h)	WATER VAPOR (g/m <sup>2</sup> /24 h)
PET	12	140	20
<b>PET METALLIZED</b>	<b>12</b>	<b>&lt;1.0</b>	<b>&lt;1.0</b>
NYLON	12	45	350
<b>NYLON METALLIZED</b>	<b>12</b>	<b>&lt;2.5</b>	<b>&lt;1.0</b>
OPP	20	1500	<1.5
<b>OPP METALLIZED</b>	<b>20</b>	<b>&lt;200</b>	<b>&lt;0.6</b>
LDPE	50	2500	1.0

(indicative values)

<http://www.filmet.it/eng/page12.htm>

**TABLE II: Needs of the New Nude Food Package**

	Moisture Barrier	Durability	Environmental Impact	Total Score
Option #1 (Stand-up Pouch)	3	5	2	<b>10</b>
Option #2 A (Clear Film)	2	3	4	<b>9</b>
Option #2 B (Metalized Film)	<b>5</b>	<b>4</b>	<b>3</b>	<b>12</b>

(1=poor, 2=fair, 3=Good, 4=Great, 5=Excellent)  
 \*Highest Score=Best Solution

**TABLE III: Prototype Packages that Showed No Leakage**

PASS or FAIL	# of Feet	mmHg	inHg
1. PASS	10,200	521	20.5
2. FAIL	350	0	0
3. PASS	10,100	523	20.5
4. PASS	10,100	521	20.5
5. PASS	10,200	522	20.5
6. PASS	10,200	521	20.5
7. PASS	10,100	523	20.5