REDUCING THE COST OF PRODUCTION OF CURD BY INTRODUCING BIODEGRADABLE PACKAGING MATERIAL.

BY

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DECLRATION

The work described in this thesis was carried out by me at the Mahaweli Authority, K.C. Marketing services and faculty of applied sciences under the supervisor of Mr. M. D. Piyathilaka, Mr. Aruna Sri Wanasinghe and Mr. Jagath Wansapala a report on this has not been submitted to any other university for another degree.

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AFFECTIONATELY DEDICATED TO MY EVER LOVING PARENTS, SISTER, TEACHERS AND FRIENDS.

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ABSTRACT.

Clay pots are mostly used in Sri Lanka for packaging of curd. However this clay pots increase the cost of production of curd and cause bad environmental effect. This study was carried out to introduce a new packaging system as an alternative to clay pots to overcome these problems associated with them.

Two types of formulations were used to prepare the alternative one. Sawdust was used as one of the main raw materials with different binding agents with different concentrations as a first type of formula. The particle size of sawdust was also changed in each system.

Banana withered was used a one of the main raw materials in the second formula with different binding agent and different concentrations calcium hypocloride was used in different concentration as bleaching agent. The particle size of fibre was also changed in each operation.

Finally all the samples made were tested for physical and microbial tests prescribed by the Sri Lanka Standard Institute.

The samples made using sawdust were rejected due to its non-consistency. The samples made using banana withered were accepted at 5% significant level. Sample number scw 423 was statistical selected as a best samples among them.

Even though the new fibre bases packaging has following advantages, low cost, biodegradability, and low weight, printing ability, resistance to breakage Further biochemical analysis are to be needed before this packaging system introduce to the market

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CHAPTER 1.

1. 1. INTRODUCTION.

Curd is a most important milk product used in south Asian countries. Nutritive value almost remains the same as in milk. During the curd formations the lactose is converted in to the lactic acid, It curdless the milk proteins. Curd starter cultures containing a combination of *lacto bacillus* and *streptococcus*. Normally deterioration of curd may occur in case there is a contamination with yeast mold and gas producing bacteria together with starter.

Milk is a very perishable food and being a nutrias liquid. It is a good source for the growth of micro-organism either present in the milk or introduced during handling milk, must therefore be handled with care to keep it safe for consumption thus bacteria can easily attack and can rapidly multiply. Hence in milk industry milk processing means enhancement of keeping quality of milk. This milk procession became very important to increase its keeping quality.

Milk products packaging is intended to preserve food against spoilage and contamination and extended its shelf life. Yet it offers much more to the manufacturer and consumer. It provides containment (holding the product) protection (quality, safety, freshness) information (graphics, labels) and utility of use or convenience. The increased consumer demand for high quality, long shelf life, ready to eat foods has initiated the development of mildly preserved products that keep their natural and fresh appearance as long as possible and at the some time are safe to eat.

Packaging is an important element in many mild preservation concepts The packaging materials provide a physical protection and create the physicochemical conditions around a food product. That is essential for obtaining a satisfactory shelf life. The packaging system based on a proper choice of the packaging material endowed with appropriate gas- and water barrier properties, prevents product deterioration due to chemical and biological factors and maintains the hygiene status despite frequent handling.

Plastic materials are most often used for food packaging to date Plastic packaging materials are convenient to use and some what lower in cost and printability But it cause environmental problems as it can not reuse or degradable. As well as wheying off some extent

Glass bottles are used for curd packaging. This type package use is small-scale production in rural areas. Glass bottle production cost is high but can use refillable or reusable. This one also wheying off.

Clay pots are used as the packaging materiel for curd since long time and it is the major packaging material for curd. Clay pots play important role as packaging materials as it absorb the excess acid produced during the fermentation. There for better texture give to the curd. But the cost of production is high for clay pots and due to it is breakability it is not convenient for transportation.

The actual unit packaging material cost as a percentage of the total production cost for commodity dairy products. Such as yogurt and cheese. It is usually between 5-10% percent. But expense of clay pot contributes 20-30% from the production cost of curd. Clay pots are difficult to transport. It is breakability, high weight and thickness is higher. There for it is difficult to transport and refrigerate. Clay pots have not good appearance and difficult to printability features. It contributes solid particles to the curd to some extend. As well as special clay is wanted as a row material. That one is not found to the every were there for cost is high, other wise some soil particles run off the with water and settle down the water sources bottoms and clay pots not degradable as a soil particles even after the thousand years pass.

Due to the problems associated with plastic, glass and mostly clay packages dairy industry looks at a new package, which can overcome above problems. Since biodegradable, low cost cellulose packages have a good trend in the food industry application to dairy is feasible even cellulose is abundant and biodegradable. It can be used as a component of a good packaging material. According to address the above problems following objective were set as follows

1. 2. OBJECTIVES.

Thus the objectives of this study are to identify the low cost biodegradable packaging Which ensure the safe delivery to the final user in the good condition

CHAPTER 2.

2. REVIEW OF LITERATURE.

2.1. PACKAGING SYSTEMS FOR CURD.

2.1.1. GLASS BOTTLE.

Glass is an important factor in the presentation of food and considerable quantities of bottles, jars, vessels, containers of very kind are used in food industries. While being fully transparent, glass containers are made in colour, either translation or opaque patterned or plain. Glass is hygienic being inert to mould growths. It may be filled with hot or cold products and when empty may be cleaned or washed and sterilized. It is not affected by moisture penetration, odour or gases and for mass produced forms or bottling and packaging.

The fact that bottled containers reveal the contents to full view adds much to sales appeal and product examination of contents at the point of sale. Arrangement the wide variety of liquids, semi liquids, granulated items, powders, tablets and other item may obtain individual designs and foncy shapes. Which may be package in glass renders them important consideration in packaging programs for food products. It goes without saying that for beverages and drinks the glass container is a "must" in most instances

Colourless glass is predominantly used in packaging foods several colours are now available including blue, amber and green shades but curd packaging are mostly use colourless bottle. The wide-mouth container obviously lends it self to more rapid filling but some tolerance must be allowed where neck, height and bottle capacity are considerations The glass container can cost relatively little as compared with other materials Other wise bottle can use refillable or reusable packaging There for can get more advantage It may cost more in the beginning but it saves money in the long run. reusable container has the major advantage of bringing your consumer back
(Frederick T P , 1986)

2.1.2. CLAY POTS.

Clay pots were used many years ago but until propeller clay pot packaging in curd That is reason fermentation period formed the extra acid Those acids absorb the

clay pots. If have many holes like honey combed there for better texture give to the curd and increase the viscosity. Clay pots and due to it is breakability, high weight and thickness is higher. It is not convenient for transportation. Clay pots have not good appearance and difficult to printability features. The row materials are not found every were and wanted more man power finally clay pots wanted to bumed there for production cost is high but three size in available in the market of the clay pots packaging curd. Consumers reluctant to use refrigeration for clay pots curd package as well as it contribute solid particles to the curd to some extent.
(For more details table 2.1)

TABLE 2.1 CLAY POTS.

Size	Prize in curd (RS)	Prize in clay pots (RS)	Packaging cost percentage	Weight of the pots (g)
100ml	12.00	6.00	50%	160-180
500ml	35.00	12.00-15.00	33.6%	350-420
750ml	60.00	18.00	30%	600-680

2.1.3. PLASTIC CUP.

The food industry must provide packaging with barrier protection (against moisture, light, etc).Among the thousands of types of plastic that are created, less than two dozen are polymers utilized in food packaging. Plastic has shrink, non-shrink, flexible, semi right, and right applications, and varies in its degree of thickness. Important properties of the many types of plastics that make them good choices for packaging material include the following.

- Flexible and stretchable
- High weight
- Low temperature formability
- Resistant to breakage, with high burst strength
- Strong heat seal ability
- Versatile in its barrier properties to O_2 moisture and light

Basic hydrocarbon building blocks such as ethane and methane, which are derived from natural gas and petroleum, form organic chemical compounds called monomers. (Polyethylene, — CH_2 — CH_2 —)

Plastic has multiple functions as a packaging material, including use in bottles and jars, closures, coatings, films, pouches, tubes and trays.

Polyethylene (PE) is most common and the least expensive plastic .it is a water vapour (moisture) barrier and prevents dehydration and freezer bum, As well as cheaper packaging But if cause environmental problems.
(Vickie A. V., 1992)

2. 1. 4. PAPER CUP.

Paper is derived from the pulp of wood and may contain additives such as aluminium particle laminators, plastic coating, resins, or waxes. These additives provides burst strength, take protection, and grease and tear resistance, as well as barrier properties that assure freshness, protect the packaged food against vapour loss and environmental contaminants, and increase shelf life. Varying thickness as paper may be used to achieve thicker and more rigid packaging.

_Paper is thin and flexible, typically used in bags and wrappers. Kraft paper is the strongest paper. It may be bleached and used as butcher wrap or may remain unbleached and used in grocery bags.

_Paper board is thicker and more rigid. Oven able paperboard is made fore use in either convention al or microwave ovens by coating paperboard with polyester

_Multilayars of paper form fibreboard, which is recognized as "cardboard"

When packaging serves as a primary container for food, it is a food contact surface and must be coated or treated accordingly For bakery products may be laminated to improve burst-wet strength, grease and tear resistance, or prevent loss of moisture Paperboard may be lined and formed to hold fluid milk, and corrugated paperboard may be waxed in order to package row poultry containers Recycled paper may contain small metal fragments that could be unacceptable in packaging used for microwave cooking

Their wide mouth permit of easy filling they nest while in store prior to filling and save space in this way cups used for beverages have many advantages. In that they are leak proof, light, and ready to drink from Most type are coated to with stand the acids of fruit juices thus preventing liquid penetration in to paper or board.
(Frederick T. P., 1986)

2.1.4.1. PULPING AND BLEACHING.

Wood logs were soaked in water for two to three days and debarked. Chipping was performed in a defibrator laboratory chipper. This produced chips of 12–14mm lengths. Shredding separated the chip bundles and screening was not necessary, as the chips were more or less of uniform size suited for pulping. The chips were then stored in polythene bags.
The cooking was performed in 2-liter stainless steel autoclaves. Dissolving Sodium sulphide and Sodium hydroxide separately made cooking liquor. The autoclaves were heated to 110°Cand pre sulfonation was performed for 30 min. The cooked chips were washed in both hot and cool water.

Table 2.2- BLEACHING OF ALKALINE SULFITE PULP WITH AN INITIAL BRIGHTNESS.

Bleaching Agent	% on U.D pulp	Temperature C	Consis-tency %	pH	Time Hrs.	Residue chemicals on O.D pulp %	Brightness Elrepho
Peroxide	1					Nil	45.6
	2	70	7	9.6 10.5	2	0.2	50 4
	3					0 4	53 2
Hypo chlorite	6					Nil	40 0
	8	40	6	8 6 9 0	3	Nil	40 8
	10					Nil	41 3

A bleaching study of the alkaline sulfite pulps was carried out in a laboratory scale using 10 00 Gm of over dry pulp Bleaching trials were performed with hypoclorite and single stage peroxide (For more details Table 2 2)
(Farook A S 1978)

2.1.4.2. BINDING AGENT.

Edible and biodegradable films must cope with a number of specific functional requirements (moisture barrier, gas barrier, water or lipid solubility, colour and appearance, mechanical and theological characteristics, non toxicity, etc.)These properties are dependent on the type of material used, its formation and application. Plastiicizers, cross-linking agents, anti-microbial, anti-oxygen agents, texture agents, etc. can be added to the film.

The mechanical property of edible or biodegradable films depends on the type of film forming material and especially on is structural cohesion. Cohesion depends on the structure of the polymer and specially its molecular length geometry, molecular weight distribution and the type and position of its lateral groups.

The mechanical properties are also linked with the film forming condition for example the puncture strength of gluten based films obtain from a dispersion in ethanol, water and acetic acid is also strongly dependent on film forming conditions.

Plasticizer of the polymeric network can enhance the mechanical properties of films Reduction of the intermolecular forces between polymer chins facilitates extensibility of the film. However this also result in reducing the gas, vapor and solute barrier properties of the film. Water is the most common plastifier and is very difficult to control in biopolymers, which are generally more or less hydrophobic. Plasticization of biopolymeric films is thus dependent on the usage conditions, especially relative humidity However the drawback of this phenomenon is that it makes biopolymer-packaging moisture sensitive
(Ackermann P et al , 1997)

2. 1. 4. 3. WAX COATING.

Wax has often been described as a versatile material. its outstanding water resistance and moisture proof properties in the packaging processes Current packaging demands for waxed materials are great indeed and some 70 percent of the petroleum wax for the home market

Coating spared temperature of wax and pressure will vary relative to the ultimate requirements of the finished waxed paper obviously, where printing is required, this must take place before the actual waxing process, as wax will resist printing ink and moisture in general.

When only a little wax is wanted on the paper's surface the rollers are heated. The product is termed "dry waxed" paper. In the "wet waxing" process the paper is completely immersed in a both of molten wax often, which it passes. Waxed cups are used for both hot and cold drinks. In the food industry spraying coats some waxed cartoons but the fundamental need is a good all over coating of wax with a high gloss finish.
(Frederick T. P., 1986)

Paraffin lining or coating are excellent for such food as beverages, soft drinks syrups, vinegar, water, cider, fruit juices, sauerkraut, wine, and certain acids and chemicals. One disadvantage associated with the waxed carton is its tendency to leak and despite improvements in manufacture. Petroleum derived paraffin and microcrystalline waxes were non-toxic and non-carcinogenic. Paraffin wax is non-odour and white colour
(www.phy.bns ac.uk)

2.2. FUNCTIONS OF PACKAGE.

If yogurt is to reach the consumer in a sound condition, the packaging material will play an important role, and the retail package should be designed to meet the requirements, to provide protection to be easy to handle, to provide a vehicle for a message and so on

2.2.1. PROTECTION.

Curd is a highly perishable product and the purpose of the container is to protect if form the environment That is dirt or other foreign bodies, microorganisms, which can affect the keeping quality of curd, gases, which can help the yeast's and moulds to grow and spoil the product, and light which may cause discoloration of curd or possibly

oxidation of the fat. Product protection also seeks to avoid spillage, pilferage or loss by evaporation. The latter aspect is doubly important since loss of moisture can not only affect the chemical composition of the product but may also lead to deviations from the declared weight on the package and possible problems with the weights and measures authorities. In addition the package must prevent the loss of flavor volatile or the absorption of undesirable odors. Environmental aspects such as light and temperature on the quality of yogurt or curd packaged in different containers.
(Tamine A. y., 1999)

2.2.2. EASE OF HANDLING.

Curd and related product usually exist in the form of viscous liquids the retail container must provide a convenient means of handling the product in the factory during storage and transport, and thought out the sale period in super markets and shops.

2.2.3. A MESSAGE.

The printing and other graphic work on the exterior or the package will suave to provide the product with a "brand image" and /or display a message to persuade a potation buyer to purchase and will contain the information proposed in the guidelines for food labeling such as,

- Identify of the product,
- Name and address of the manufacture,
- Approximate chemical composition or nutritional data of the product, or the Ingredients listed in descending order by weight,
- Best before date,
- Possible suggestions of recipes or other instructions for use.

(Tamine A Y 1999)

2. 2. 4. MISCELLANEOUS FUNCTIONS.

In general a packaging materials, which is in direct contact with a foodstuff, must be non-toxic and no chemical reactions. Should take place between the material and the food product. It is against this general background that the following approaches to marketing curd have evolved. Most important general requirements of food packages for the following:

- Non-toxic
- Protect against contamination from microorganisms
- Act as a barrier to moisture loss or gain and O_2 ingress (entrance)
- Protect against ingress of odorous or environmental toxicants
- Filter out harmful U. V. light
- Provide resistance to physical damages
- Be transparent
- Be temper (change resistance)
- Easy to open
- Have dispensing (take out) and resealing features
- Be disposed off easily
- Meat size, shape and weight requirements.
- Have appearance
- Printability features
- Low cost
- Compatible with the food
- Special features such as unitizing (oneness) group of products. Together care taken by the food producer to prepare wholesome and attractive food must be matched by the care taken to select suitable and compatible packaging

(Tamine A Y 1999)

2. 3. ECONOMICS OF PACKAGING.

Economics can be defined as the science of production and distribution of resources They concern not only the production and distribution but also the selling of products The surface design or package shape can have a significant effect of sales

For and industrial product, however, the identification and physical protection provided by the pack are the critical factors. In each of these cases the cost efficiency of the pack is identified not only by it is basic cost but also by it is effective contribution to the whole operations.

The actual unit packaging material cost as a percentage of the total productions cost varies according to the product type. For commodity food products such as sugar and flour, it is usually below 5%. For other consumer products such as detergents, toilet soaps and biscuits the figure varies between 5%. In the areas of toiletries and cosmetic products the packaging cost is often equal to greater than that of the product it self.

There is no direct relation between product and packaging price. For example, expensive items such as electrical appliances are often packaged at a cost of less than 5% of the total production cost. Cost consideration plays a major role in the work of all the people concerned with packaging operations.
(BnstonJ H. and Weill T. J. 1979)

2. 3. 1. ELEMANTS OF PACKAGING COST.

It was stressed that cost associated with packaging are incurred right through any operations and that basic material or container costs should never be considered in isolations. There are many case histories in the packaging area, where changes made on the basis of considering a packaging material price reduction only, have ultimately resulted in an overall increased in total product cost instead of the expected saving.

2. 3. 1. 1. UNIT PACK COST.

This is one of the easy-to-measure areas of cost as the basic material or container price is stated on the supplier's quotation This quotation will be based on either the user's specification The actual unit price on the quotation will depend on the following factors

Volume for the majority of packaging material items the unit price will be directly affected by the quantity ordered. the larger order the lower the price This is particularly

true for manufacturing operations involving large machinery such as glass container manufacture or gravure printing, where the start- up, or set-up, time in the supplier's operation is a lengthy process.
(Briston J. H. and Weill T. J., 1979)

2. 3. 1. 2. STORAGE / HANDLING.

The price advantage gained from large volume ordering has to be considered in comparison to two other factors. First, the amount of capital that will be employed in holding large packaging material inventories. And second the cost of labor and space involved in the storage and handling of the materials. One of the buyers' main responsibilities is to study the relationship between unit pack price and volume and to decide what level of inventories to maintain. He will be influenced in his decision by the costs involved in the handling and storage of the materials. In this situation the extra storage cost incurred by the supplier will probably be included in the unit pack price.
(Briston J. H. and Weill T. J., 1979)

2. 3. 2. PRODUCTION OPERATIONS.

The production of packaging materials to close tolerances, suitable for running on high-speed automatic equipment, makes a vital contribution to overall efficiency in today's high-speed operation.

2. 3. 2. 1. COST AREAS.

There are three main areas of cost in the packaging or filling operations, materials, labor and overheads

The fixed costs for a given packaging line covers the machinery depreciation, the direct labor employed on the line and a proportion of the total overheads Fixed costs can be lowered by more efficient equipment utilization or by a reduction in labor costs or overheads Savings in raw materials or packaging reduce variable costs
(Briston J H and Weill T J., 1979)

2. 3. 2. 2. MACHINE EFFICIENCY.

The overall efficiency of a packaging machine, or line, is judged by the cost of the finished product coming the line. This is influenced. Not only by the machine speed and the labor involved but also by the unit pack cost of the materials used.

Development in both packaging materials and equipment has significantly reduced costs in these areas.

2. 3. 2. 3. LABOUR COSTS.

Not all-packaging operations are automatic or even semiautomatic. There are still many operations which for reasons of either completely manual.

The manager's aim in this situation is to achieve maximum out put per packer or operator The main secret of success here is the efficient planing and layout of the packing operation Where possible, conveyors should be used to pace the line.

Effective supervision also plays a big port in the achievement of high outputs from that type of operation Often, are used as a method of raising production levels.

2. 3. 2. 4. PACKAGING LOSSES.

There are many potential areas of packaging material losses or 'shrinkage' in the production operation Some of these will be unavoidable, for example, materials, which are sampled by the quality measurement, section and tested to destruction It has already been mentioned in the section storage and handling cost, that losses can be incurred by damage during this period

The other two main potential loss areas are both concerned with the packaging operations First, there is a potential loss during machinery start-ups, whether it be at the beginning of a shift, after a break, or after a size changeover Second, there are the losses caused when machinery problems are experienced and off- standard packs are produced

2. 3. 3. WAREHOUSING.

Package shape has an influence on storage costs because it effects the utilization of space. This is obviously important in the case of frozen foods.

Where the cost of low temperature storage is high. The packaging manager, when considering outer case design has to take the space utilization factor in to account along with the requirements for the stability, economy, surface design, etc.

Packaging strength is another factor, which can affect the costs of storage. Products can be stored in two ways, either in racks several cases high, or dead stacked (with or without pallets), up to the roof.
(Briston J. H. and Weill T. J., 1979)

2. 3. 4. DISTRIBUTION.

The operations involved in moving the product from the user's warehouse may involve the use of several different forms of transport. In a example, road, rail, or a combination of the two, are the main methods employed. For export shipment, the trains' rotation may be by sea or air. The performance and physical properties of the package can have a significant effect in this area.

2. 3. 5. TRANSPORT COSTS.

These are ground by either the finished pack weight or volume They are also, of course, dependent on the distance and the value of the item being handled Air transport is a typical example where the total weights is the main factor affecting the cost for a given journey This can also, however, occur with road transport where the product has a high weight to volume ratio and the transport is loaded to its maximum permitted weight, before it is completely full

Package weight and dimension cost there for . affect costs in this area Often effects the distribution costs The new package not only has a lower unit price. but also by nature of its lower volume, results in a lower distribution cost. For air transport, a reduction in package weight can have a major effect on cost.

2.3.6. REDUCTION OF PACKING COST.

The packing affects the total product cost were considerable and the point was made that all the elements of the total operation must be considered to obtain the true packing cost. The same applies when considering packing cost reductions. The unit pack cost is only one of the factors, which make up the total packing cost. Often it is possible to obtain an overall cost reduction by an increase in the unit pack cost.

The other important point about cost reduction exercises is that one of the objectives must be to chive the saving without an effective change in quality or liability. For example, when reducing the unit. Pack price by, say a change in material supplier; it is essential to ensure that the new supplier can deliver the material not only at a lower price but also at the same quality level.
(Briston J. H. and Weill T. J., 1979)

2.3.7. VALUE ANALYSIS TECHNIQUES.

'Value analysis', or 'value engineering' as it is some time called is a modern management cost reduction technique, which can be successfully applied to packaging operations. Basically value analysis works on the principle of assigning a function to every item involved in the operation and then studying alternative methods and cost of achieving that function. It can also be used as a method of achieving increased performance without an accompanying cost increase.

Value analysis can be valuable tools in this work many people argue that the normal type of logical cost reduction exercise and value analysis is synonymous. In many cases that are right. However, there is oar basic distinction. Cost improvement projects often involve small changes in specification, for example, a change in board weight or type for a paperboard carton, a reduction of film weight for a flexible pouch, etc. whereas value analysis takes a much broader look at the whole packaging operation.

The objective of a value analysis approach is to obtain the maximum function at the lowest cost. Three basic steps are involved.

- Define basic function of each component
- Propose alternative materials or methods to perform the some function.
- Compare costs of current and alternative methods.

CHAPTER 3.

3. MATERIALS AND METHOD.

3.1 MATERIALS.

3. 1. 1. PREPARATION OF MOULD.

Oxygen plant
Lathe machine
18 gage iron board
Amary paper
Cutting machine
Other related tools

3. 1. 2. PREPARATION OF PULP.

Banana withered
Water tank
Blender
Caustic soda
Stainless steel utensils
Measuring cylinder
Mechanical balance
Gas cooker
Glass wears

3. 1. 3. BLEACHING PROCESS.

$CaOCl_2$
Mechanical balance
Glass wears
Measuring cylinder

3. 1. 4. MATERIALS FOR PREPARATION OF SAMPLES.

Wheat flour
Cassava flour
Saw dust
Stainless steel utensils
Mechanical balance
Prepared mould
Aluminum plate
Gas cooker

3. 1. 5. MATERIALS FOR WAX COATING.

Clear paraffin wax
Oven
Paint brush
Petri dishes

3. 1. 6. MATERIALS FOR DROP TEST.

Table drops test apparatus
Meter rule

3. 1. 7. MATERIALS FOR COMPRESSION TEST .

High range mechanical balance
Weight samples materials

3.2. METHOD.

3.2.1. DESIGN OF MOULD.

Mould was designed consisting of three mechanical units One was outer mechanical unit; other was inner mechanical unit and pressure unit Inner surface of the outer mechanical unit was smoothly finished, as well as outer surface of the inner mechanical units was smoothly created. 18-size gage iron board was used to prepare the mold. The oxygen-welding units were taken to crate the mould. (See appendix 1,2,3,)

3. 2. 2. PREPARATION OF SAMPLES.

3. 2. 2. 1. PRELIMINARY STUDY.

Preliminary study was carried out using different materials, as mentioned in the Table 3.1.

TABLE 3.1. MATERIALS AND QUANTITIES FOR PRELIMINARY STUDIES.

No	Materials	Quantity as percentage
1	Saw dust Wheat flour	55% 45%
2	Saw dust Gluten	55% 45%
3	Banana withered (without bleaching) Wheat flour	75% 25%

Above mentioned materials were mixed as following manner and was filled to the mould and pressed. After that sample was dried under sun light and removed from the mould.

First one wheat flour / gluten were mixed with hot water. Saw dust was added to the mixture

Next one banana withered was soaked in water for two or three days. The pulp was made out by soaked banana withered on a blender. Particle size of the pulp was 2mm or less The pulp was boiled along 20-30 minutes with 1% NaOH solution and well washed with water Wheat flour was mixed with prepared pulp

3. 2. 2. 2. BLEACHING PROCEDURE.

Pulp was prepared as above pulp preparation method under 3 2 2 1 Then the pulp was bleached with 10% chlorine solution Finally the bleach pulp was washed off with water

3. 2. 2. 3. PREPERATION OF SAMPLE (CC217).

Cassava flour was mixed with boil water and mixed with the pulp and mixed thoroughly. The above mixtures were filled in to the mold and add the pressure. Then mould was removed. The sample was dried in the sun. Well dried sample were ware waxed by using a painting brush.(See table 3.2.)

TABLE 3. 2. MATERIALS AND QUNTITIES FOR SAMPLES.

Materials	CC217	CW348	SCW423
Banana withered pulp	75%	75%	37.5%
Saw dust	-	-	37.5%
Cassava flour	20%	-	-
Wheat flour	-	20%	20%
Wax	5%	5%	5%

CC – Cellulose pulp, Cassava flour

CW – Cellulose pulp, Wheat flour

SCW – Saw dust, Cellulose pulp, Wheat flour

3. 2. 2. 3. PREPERATION OF SAMPLE (CW348).

Wheat flour was mixed with boil water and mixed with the pulp and mixed thoroughly The above mixtures were filled in to the mold and add the pressure. Then mould was removed The sample was dried in the sun Well-dried sample was ware waxed by using a painting brush (See table 3 2)

3. 2. 2. 4. PREPERATION OF SAMPLE (SCW423).

Wheat flour was mixed with boil water and mixed with the pulp To this mixture sawdust was added and mixed thoroughly. The above mixtures were filled in to the mould and add the pressure Then mould was removed The sample was dried in the sun Well dried sample ware waxed by using a painting brush (See table 3 2)

3. 3. MECHANICAL TEST.

3. 3. 1. DROP TEST.

Test was carried out at SLSI laboratory according to standard method. Dropping height was changed as 0.5m, 1m and1.5m. Test was done in five replicates for the samples cc217, scw423, and cw348.

3. 3. 2. COMPRESSION TEST (EDG AND VERTICAL).

Test was carried out at SLSI laboratory. According to standard method. The compressive load was applied to diagonally opposite edges and vertically to the container. Test was carried out in 3 replicates for the samples cc217, scw423 and cw348.

3. 3. 3.TEST FOR CONTROL SAMPLE AND SELECT ONE.

Same size clay pot, which is currently available at the market, was taken as control sample Test 3 3 1 and 3.3.2 was carried out for the control sample.

3. 3. 4. MICROBIOLOGICAL TEST FOR SELECT SAMPLE.

Total plate count (TPC) was carried out according to James G. Cappuccino and Natalie Sherman (1983) method.

3. 3. 5. STATISTICAL ANALYSIS.

Analysis of variance was conducted on the numerical values of compression test The statistical package was used the SAS version (1998). According to statistical analyses best sample was selected

3. 4. COST EVALUATION.

Cost per one container was estimate For this estimation raw materials prices were considered for bulk production (over 10.000) and current wholesale prices

CHAPTER 4.

4. 1. RESULTS.

4. 1. 1. COMPARISON OF FINISHING.

Figure 4. 1. cw348

Figure 4.2. cc217

Figure 4. 3. scw423

4. 1. 2. RESULTS OF MECHANICAL TESTS.

4. 1. 2. 1. DROP TEST.

TABLE 4. 1. DROP TEST RESULT FOR SAMPLE.

Height	Scw423	Cw348	Cc217
0.5m	No	No	No
1.0m	No	No	No
1.5m	No	No	No

4. 1. 2. 2. COMPRESSION TEST FOR VARTICAL.

TABLE 4. 2. COMPRESSION TEST FOR VARTICAL.

No	Scw 423	Cw 348	Cc 217
1	80kg	60kg	60kg
2	74.5kg	67.5kg	61kg
3	76kg	69kg	56kg

4. 1. 2. 3. COPPRESSION TEST FOR EDGES.

TABLE 4. 3. COMPRESSION TEST FOR EDGES.

No	Scw 423	Cw 348	Cc 217
1	10kg	11kg	16kg
2	16.5kg	9kg	10.5kg
3	14kg	12kg	13kg

4. 1. 3. COMPARISON OF SELECTED SAMPLE WITH COTROL SAMPLE.

4. 1. 3. 1. COMPARISON OF DROP TEST RESULTS.

TABLE 4. 4. COMPARISON OF DROP TEST RESULTS.

Height	Control	Scw 423
0.5m	Yes	No
	No	No
	No	No
	Yes	No
	No	No
1.0m	Yes	No
	Yes	No
	Yes	No
	No	No
	Yes	No
1.5m	Yes	No

4. 1. 3. 2. COMPARISON OF COMPRESSION TEST RESULTS. .(VERTICAL)

TABLE 4. 5. COMPARISON OF COMPRESSION TEST.(VERTICAL)

No:	Control	Scw423
1	34kg	80kg
2	29kg	74.5kg
3	32kg	76kg

4. 1. 3. 3. COMPARISON OF COMPRESSION TEST RESULTS. . (EDGS)

TABLE 4. 6. COMPARISON OF COMPRESSION TEST. (EDGS)

No:	Control	Scw423
1	21kg	10kg
2	14.5kg	16.5kg
3	18kg	14kg

4. 2. DISCUSSION.

4. 2. 1. PRELIMINARY STUDY.

In preliminary study sample, which is prepared with, saw dust and wheat flour is difficult to remove from the mould. Also cracks are appeared in drying period.

Also Sample, which prepared with saw dust and gluten was difficult to remove from the mould. Major problem of this sample is drying weakness. Due to that reason this sample gives a bad odour.

To improve quality of above two samples, study was repeated using sieved sawdust. Our aim is to get equal particle size sawdust to over come above problems. But that study was also failed. Then we considered another alternative. (Banana withered)

Sample which was prepared with banana withered and wheat flour. Gave a acceptable quality. Advantages and disadvantages of this sample compared with other samples are mentioned below.

Advantages

- Easily remove from the mould
- Easy to dry
- Minimum amount of binding agent requires.
- Cracks are not appears
- Lighter sample.
- Better finishing

Disadvantage

- Undesirable colour

4. 2. 2. PULP PREPARATION.

Major objective of soaking of banana withered is ease to blend. When particle size of the banana withered decreasing around 2mm appearance become better. When pulp preparation 1% NaOH solution use to breakdown and dissolve unwanted organic matters

4. 2. 3. WAX COATING.

After the wax coating best finish and shine Container finishing is best or not, when depend on the amount of the wax content Wax coat is one layer tendency to leak There for application of multilayers coat a wax

4. 2. 4. COMPARISON OF FINISHING.

In this study best sample is not selected base on appearance For that physical properties are used Standard procedure was not followed for the appearance comparison But scw423 can be recommended as visually good quality sample

4. 2. 5. MECHANICAL TESTS.

4. 2. 5. 1. DROP TEST.

According to the table 4. 1 There is no significant difference between scw 423, cw348, and cc217 samples That means three samples are passed in drop test. Then best sample can not be screened out using drop test.

4. 2. 5. 2. COMPRESSION TEST.(VERTICAL)

At 95% confidence level there is a significant different between 3 samples. (See appendix 1) that mean scw423 sample can bear high weight vertically. Stakability of scw423 is higher than other two samples (see appendix 4)

4. 2. 5. 3. COMPRESSION TEST. (EDGES)

At 95% confidence level there is no significant different between three samples That means three samples can be bared compression equally which applied through the edges (See appendix 5)

4. 2. 6. COMPARISON OF SELECTED SAMPLE WITH COTROL SAMPLE.

4. 2. 6. 1. COMPARISON OF DROP TEST.

According to above table it is obvious that sample scw423 (selected sample) is stronger than control one (clay pot) That means selected sample is better in rough handling than conventional clay pots Also it provides higher protection to it is content than clay pot

4. 2. 6. 2. COMPARISON OF COMPRESSION TEST. (VERTICAL)

At 95% confidence Laval there is significance different between selected sample and control one (See appendix 6) Selected sample has a higher stackability than clay pot (control sample) According to least significance deference (L S D)
(See appendix 6)

4. 2. 6. 3. COMPARISON OF COMPRESSION TEST. (EDGS)

At 95%confidance interval there is not any different between selected sample and control one Selected sample can bear stress on edges as conventional clay pot.
(See appendix 7)

4. 2. 6. 4. MICROBIOLOGICAL TEST.

Total plate count result is negligible there for no high risk about microbial activity.

4. 2. 7. COST EVALUATION FOR SELECTED SAMPLE. (OVER 10,000)

Caustic soda	40kg	RS: 1600.00
Chlorine	30Kg	RS. 1200.00
Wax	20Kg	RS 8000:00
Wheat flours	100Kg	RS 1750.00
Label	10.000	RS 4000 00
Electricity		RS 500.00
Man power		RS 12000 00

Total		RS 29050 00
		===========

Currently using clay pot costs 6 rupees According to above cost evaluation developed container costs around 3 rupees Then developed pack is one time cheaper than conventional clay pots

CHAPTER 5.

5. 1. CONCLUSIONS.

Milk is very perishable food and being a nutrias liquid it is a good source for the growth of micro-organism. Packaging is intended to preserve food against spoilage and contamination's and extended it is shelf life. In the case of development of biodegradable packaging following conclusion were gained.

According to the present project, cost was evaluated with clay pots Cost of the currently using clay pots is around 6 rupees. The developed package cost is only around 3 rupees Then developed package has one time cheaper than conventional clay pots

There were no positive microbial developments on total plate count test. Which says safe to the curd packaging and human consumption.

As it has low weight it reduce the cost of transportation Weight difference with the clay pots around 100g Clay pots are difficult to transport It is breakability and high weight and thickness is higher By consider to this developed product breakability is very low even at 1 5m beyond the ground level

Printability of the packaging surface Is very easy There for final appearance looks very good What is good today may be improved upon tomorrow

5. 2 RECOMMENDATIONS FOR FURTHER STUDY.

- Manufacturing of best fibres to form a package as a primary ingredient
- Identification of best bleaching condition and product drying condition
- Cross contamination with packaging material and curd (chemical analysis)
- Evaluation of biodegradability (how long at what extent)

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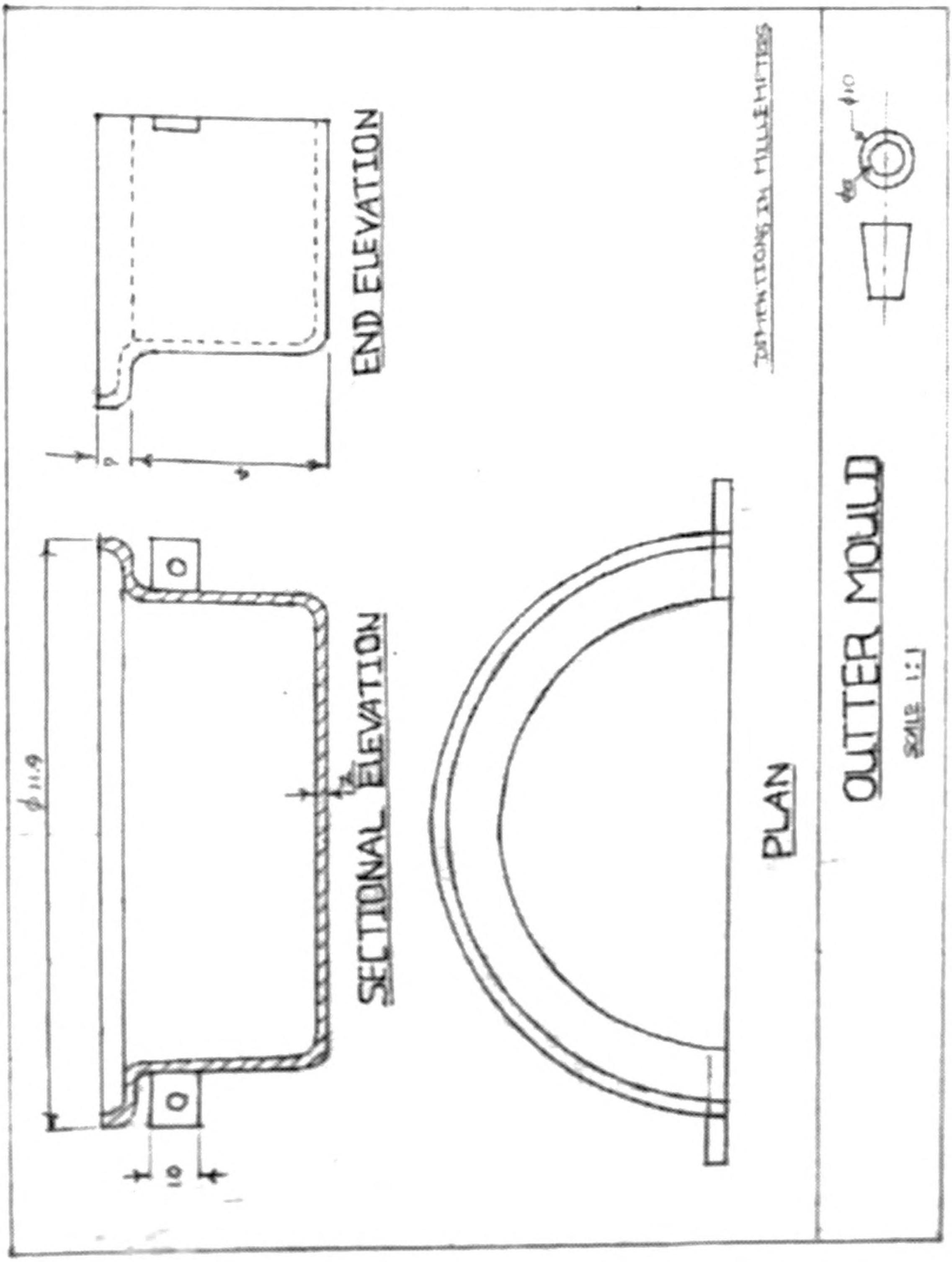
APPENDIX 1.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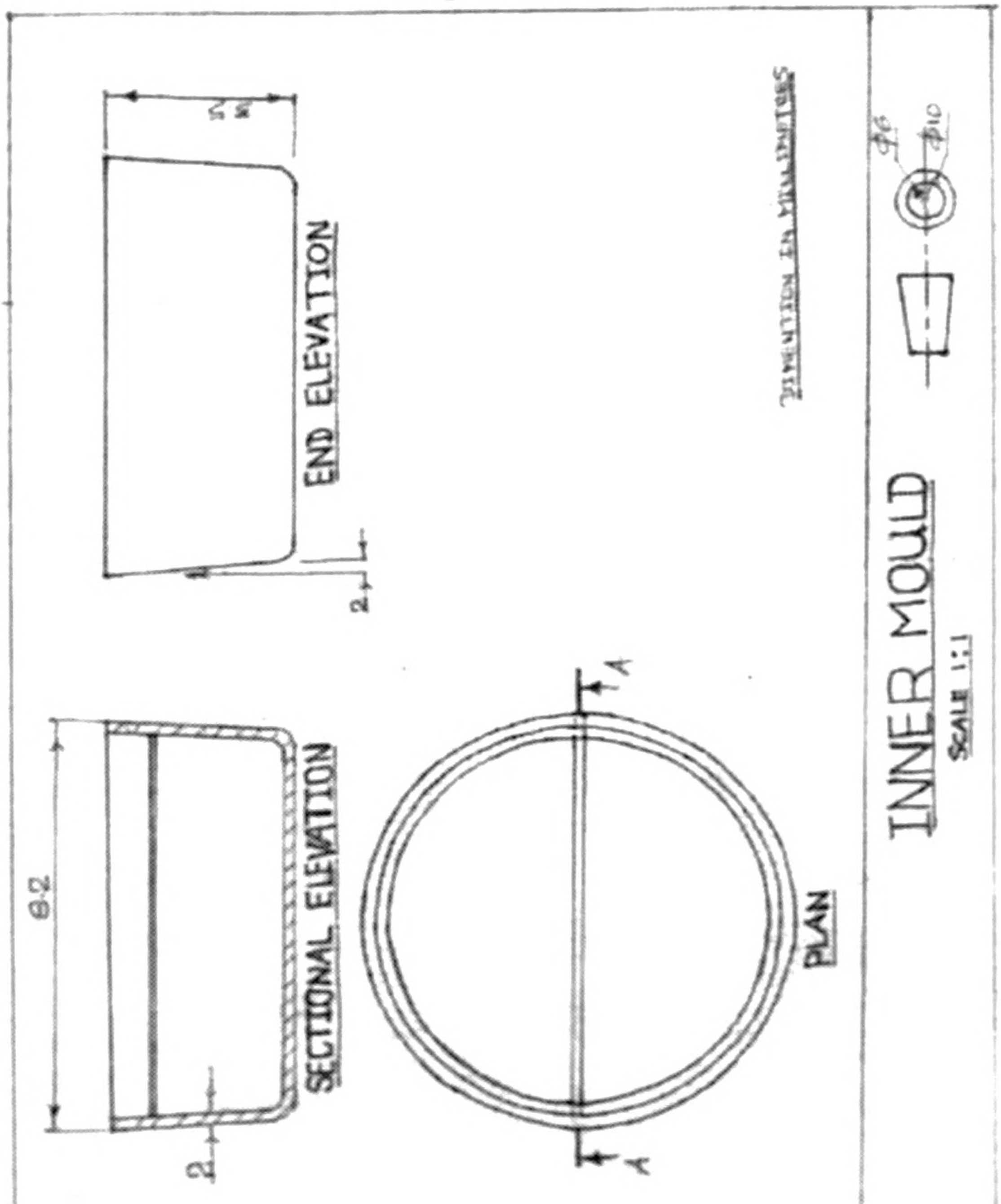
OUTTER MOULD
SCALE 1:1

APPENDIX 2.



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82
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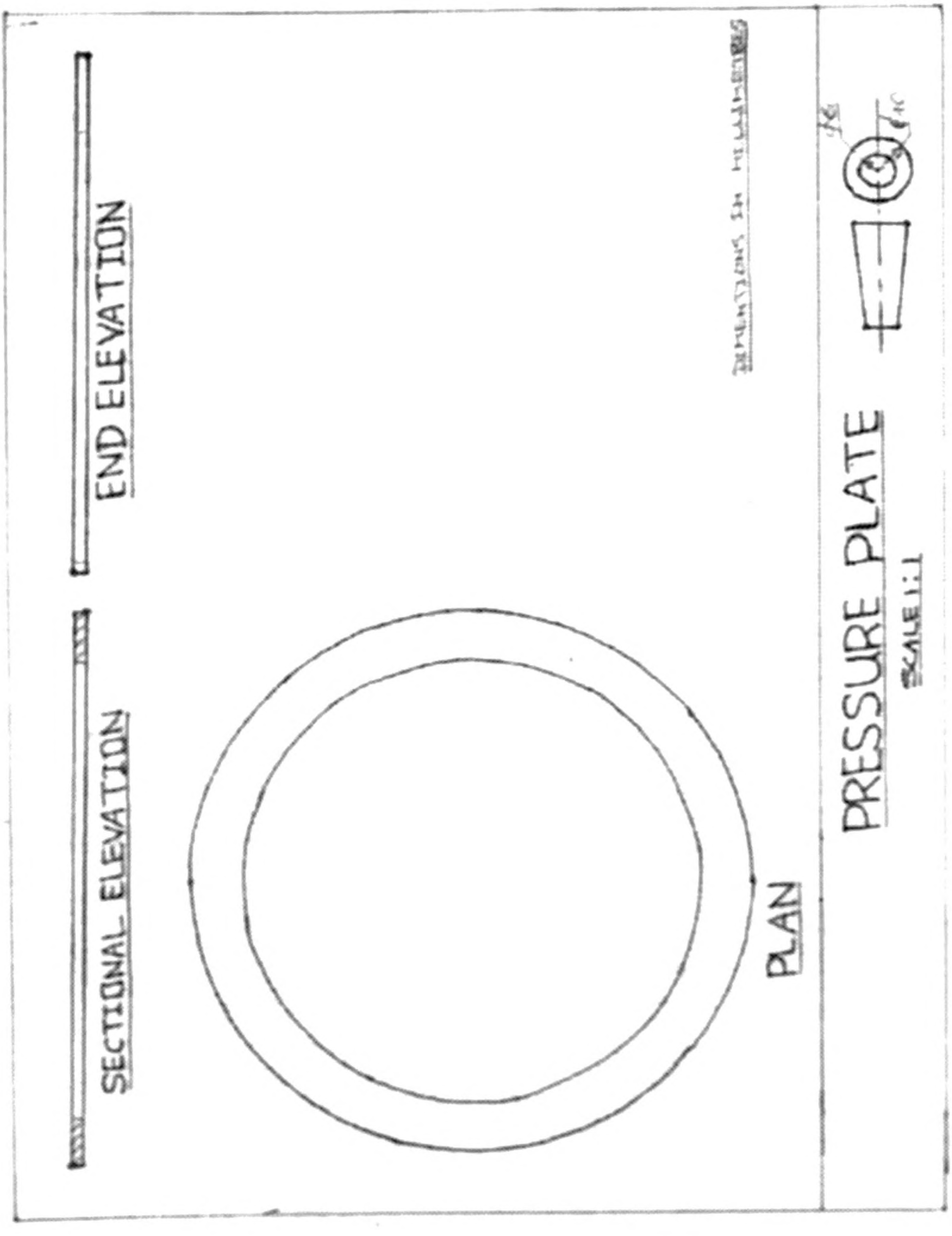
INNER MOULD
SCALE 1:1

APPENDIX 3.


SECTIONAL ELEVATION
END ELEVATION
PLAN
PRESSURE PLATE
SCALE 1:1

APPENDIX 4.

The SAS System 1

Analysis of Vanance Procedure Class Level Information

Class	Levels	Values
TRT	3	1 2 3

Number of observations in data set = 9

The SAS System 2

Analysis of Vanance Procedure

Dependent Vanable WEIGHT

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	488 7222222	244 3611111	19.12	0.0025
Error	6	76 6666667	12.7777778		
Corrected Total	8	565 3888889			

R-Square	C V	Root MSE	WEIGHT Mean
0 864400	5 326393	3 574602	67 11111

The SAS System 3

Analysis of Vanance Procedure

T tests (LSD) for vanable WEIGHT

Alpha= 0 05 df= 6 MSE= 12 77778

Cntical Value of T= 2 45

Least Significant Difference= 7 1417

Means with the same letter are not significantly different

T Grouping	Mean	N	TRT
A	76 833	3	1
B	65 500	3	2
B	59 000	3	3

APPENDIX 5.

The SAS System 1

Analysis of Vanance Procedure

Class Level Information

Class	Levels	Values
TRT	3	1 2 3

Number of observations in data set = 9

The SAS System 2

Analysis of Vanance Procedure

Dependent Vanable WEIGHT

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	14 38888889	7 19444444	1.04	0 4081
Error	6	41 33333333	6 88888889		
Corrected Total	8	55 72222222			

R-Square	C V	Root MSE	WEIGHT Mean
0 258225	21 09109	2 624669	12 44444

The SAS System 3

Analysis of Vanance Procedure

Level of TRT	N	-----------WEIGHT---------- Mean	SD
1	3	13 5000000	3 27871926
2	3	10 6666667	1 52752523
3	3	13 1666667	2 75378527

APPENDIX 6.

The SAS System 1

Analysis of Vanance Procedure

Class Level Information

Class	Levels	Values
TRT	2	1 2

Number of observations in data set = 6

The SAS System 2

Analysis of Vanance Procedure

Dependent Vanable WEIGHT

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	3060 041667	3060.041667	424.51	0 0001
Error	4	28.833333	7.208333		
Corrected Total	5	3088.875000			

R-Square	C V	Root MSE	WEIGHT Mean
0 990665	4 949003	2 684834	54 25000

The SAS System 3

Analysis of Vanance Procedure

T tests (LSD) for vanable WEIGHT

NOTE This test controls the type I compansonwise error rate not the expenmentwise error rate

Alpha= 0 05 df= 4 MSE= 7 208333

Cntical Value of T= 2 78

Least Significant Difference 6 0864

Means with the same letter are not significantly different

T Grouping	Mean	N	TRT
A	76 833	3	2
B	31 667	3	1

APPENDIX 7.

The SAS System 1

Analysis of Vanance Procedure

Class Level Information

Class	Levels	Values
TRT	2	1 2

Number of observations in data set = 6

SAS System 2

Analysis of Variance Procedure

Dependent Vanable WEIGHT

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	28 16666667	28.16666667	2.64	0.1795
Error	4	42.66666667	10.66666667		
Corrected Total	5	70 83333333			

R-Square	C V	Root MSE	WEIGHT Mean
0 397647	20 84672	3 265986	15.66667

The SAS System 3

Analysis of Vanance Procedure

Level of TRT	N	WEIGHT Mean	WEIGHT SD
1	3	17 8333333	3 25320355
2	3	13 5000000	3 27871926

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