

Design and Development of a Weaning Food Processing Equipment for use at Institutional level.

B.D.M.P Bandara, R.C. Verma and G.P Sharma

Abstract: Preparing paste from cereal, pulses, fruits and vegetable is the most important operation in the process of preparing home made weaning foods. At present, there is no specially designed equipment for processing home made weaning foods for use at institutional level. Hence, the conventional and alternative methods and equipments have to be used for processing weaning foods. These methods besides being time consuming, laborious and inefficient, the product is poor in quality without making required particle sizes for weaning baby and moreover contamination of foods may also occur. Therefore a hand operated weaning food processing equipment was designed and developed for processing home made weaning foods for use at institutional level.

The performance of the developed weaning food processing equipment was evaluated at different batch sizes. It was found that the average time for processing a batch (4kg) was estimated to be about 8.47min. The extraction efficiency of the developed equipment was found between 92.53 and 94.48 per cent. The average power requirement of the developed weaning food processing equipment has been observed to be about 0.073W, when equipment was operated with batch of 4kg at a time. The average moisture content, density and viscosity for the weaning paste produce with the developed equipment were found to be 81.5 per cent, 1030 kg/m³ and 4.431 Pa.s respectively.

Keywords: Weaning, weaning foods, equipments, design, evaluation, extraction

1. Introduction

Weaning is a process by which foods other than breast milk are gradually introduced in to the child's diet first to complement breast milk and progressively to replace it and adapt the child to the adult diet. Weaning is therefore an important period of adaptation from breast feediy, which satisfies all nutritional needs of the infant for the first few months, to a mixed diet containing solid foods [WHO/UNICEF,1981].

The first year of life is characterized by rapid growth and changes in body composition. Most healthy infants double their weight in 6 months and triple it in a year. The progression from breast milk to solid foods is based not only on the infant's nutrient requirements, but also on developmental maturation and environmental influences [Hendrick and Badruddin, 1992].

The first consequence of failure to complement breast milk is a falling off growth and development. The second is lowering of resistance to infection [Scrimshaw and Wallerstein, 1982].

The factors leading to malnutrition in children is "constraints to successful weaning practices." Malnutrition in children under the age of five

years starts mainly during the weaning period [Anonymous, 1981]. Hence timely complementation of breast milk with foods that supply additional protein, energy, iron, and other nutrients is essential for normal growth and development, for resistance to infection, and for the prevention of increased morbidity and mortality.

This critical transition period commences with the need to introduce food to complement breast milk and ends when the child is fully consuming the family diet [Scrimshaw and Wallerstein, 1982].

During this period, several solid foods are introduced step by step to weaning infant in the form of paste, semi-liquid or juice after meshing, sieving or crushing of cooked or uncooked cereal, pulses, fruits and vegetables. A reasonable amount of roughage in the diet is useful in maintaining regular bowel action. If there is a tendency to constipation, increased

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High intake, regular exercise and an increase in flivim vegetables and fruit in the diet will usually achieve the desired result [Mitchell, 1970].

Weaning foods can be prepared at home or some commercially prepared strained foods are available in the market. Either method can safely meet the nutritional needs of the infant. However, a number of companies in the last few years have altered the additives in their baby food products. Many of the commercial dessert items have a high content of starch filler and add little to the diet other than calories. If parents are preparing the strained food themselves, they must be sure to prepare a well-balanced diet. And they can prepare just enough food to be fed immediately [Tackett, 1981].

A workshop report [Anonymous, 1981] published says that the preparation of weaning foods manually would be useful for babies. It does not change the nutritional composition of the foods, especially when preparing juices and paste from fruits and vegetables, as vitamins are not destroyed due to elimination of thermal heat during processing. And also preparation of weaning foods at home has several attractive considerations. One is, all foods are not available in the cereal form in the market. Another is, use of a variety of raw material and the fact that the food is boiled as part of the cooking thus reducing potential contamination.

Present methods of preparing homemade weaning foods are in many ways laborious, time-consuming and inefficient, coupled with shortage of suitable utensils, storage facilities, etc. form strong constraints against these foods [Anonymous, 1981].

At present, in urban and semi urban areas both mother and father in most of the families are engaged in jobs. So they eventually use day-care centers to keep their babies. And also as parents continue to work during weekends, evenings, and late nights, the demand will grow significantly for child-care programs that can provide care during nontraditional hours. So, the day-care centers are becoming popular in most of the countries in the world for even weaning babies. The places where weaning age babies can stay or gather are; Nursery hospitals, Children's homes, joint families etc. In these places weaning food has to be prepared in larger quantities at a time.

Due to unavailability of proper equipment for preparing weaning foods at institutional level as mentioned before more difficulties. In some day-care centers, they do not prepare weaning foods due to unavailability of proper equipments and parents should prepare the required food for the baby and supply to the day-care center.

If parents prepare and supply foods for their baby, such foods should be stored in a proper container and a place. So it requires additional work for the feeder; i.e. foods should be fed before it goes state or change its texture. However this method of preparing foods or keeping it for few hours before feeding is not a good weaning practice. Most appropriate way is, preparing weaning foods by institutional people at the required time and feed immediately. Therefore necessary equipment for preparing weaning foods should be available.

The process of preparing home made weaning foods from cereal, pulses and vegetable include two major operations i.e., boiling of cleaned and washed cereal, pulses and vegetables and making boiled product into a paste. Similarly the process of preparing weaning foods from ripen fruits include two major operations i.e., peeling and cutting fruits and making into a paste. In both cases, making a paste is crucial than other operations as final product should be uniform with desired particle size, fibrous nature materials in the food should be separated and contamination of food should be avoided during processing.

At present, there is no specially designed equipment for processing home made weaning foods for use at institutional level. However, the conventional and alternative methods and equipment used for preparing weaning foods are; bowl and spoon, wire mesh, cloths, onion and chilly cutter, juice extractor, beater, blender, baby food grinder, kitchen fork or knife, etc.

These equipment have the following limitations in their use;

1. Conventional methods; use of bowl and spoon, wire mesh, cloths are highly labour intensive, time consuming and inefficient.
2. Alternative methods; use of onion and chilly cutter, juice extractor, beater, blender, baby food grinder, kitchen fork or knife cannot be used for preparing all solid weaning foods.



3. In these methods (except wire mesh and spoon) desired particle size can not be maintained; hence final product is not uniform.
4. These methods are not capable of fulfilling the weaning food demand of an institutional place.
5. These equipment and methods are not hygienically satisfactory although it is one of the primary requirements of any food processing equipment.

Although this process is important and essential, no researchers have put effort to develop a weaning food processing equipment for use at institutional level. Hence the need was felt to develop a proper equipment for this important process which will certainly lead for making the process efficient and time saving.

Therefore, the objectives of the present work was to design and develop a low cost, manually operated equipment for preparing home-made weaning foods and evaluate its performance by determining its power requirement, time taken for each batch operation, efficiency of the equipment and properties of the final product; such as viscosity, moisture content, and density.

2. Design

The volumetric food capacity of the equipment is 4000 cm³. The extraction chamber capacity is 3000cm³. Fig2.1 and Fig2.4 shows the weaning food processing equipment. It consists of a hopper, casing, cover plate, beater assembly, power transmission assembly, sieve assembly and frame. All the components that contact with foods and frame were fabricated using stainless steel (SS)-304.

Casing consists of two parts. The bottom part that consists of a hemi cylindrical section and a right box section with a cross sectional dimension of 200mm x 62.5mm and 137.5mm height is fitted to hemi cylindrical section. The hopper was fabricated using 14 BWG (2.1mm) SS-304 sheets. The dimension of the hopper bottom was selected as 246mm x 60mm to fit on the top of the casing. Hopper having top rectangular cross sectional area of 371mm x 185mm, hopper plate angle 45° to the horizontal and the total vertical height 112.5mm was fixed to the casing. A shaft containing four identical beaters welded at 90° angular distance to each and located at mid of the casing are mounted on a rigid frame by

using two pillow block bearings. The beater blades are rotated by a lever arm. A sieve fabricated from SS wire mesh is fixed to bottom of the casing with the help of a supporting frame. Frame has the overall dimensions of 440 x 250 x 497 mm. The handle was fabricated by using a cylindrical solid nylon bar having diameter of 32 mm and length of 100 mm. A hole of diameter 8mm was drilled throughout the length of this solid nylon bar and a rod (dia -8mm, 120mm long, SS-304) passing through this hole was used to fix the handle to lever arm. Nylon handle can rotate freely on the rod while operating the equipment. In the operation the food is subjected to impact forces and shearing. The paste and juices come out through the sieve which is fixed to the casing at the bottom.

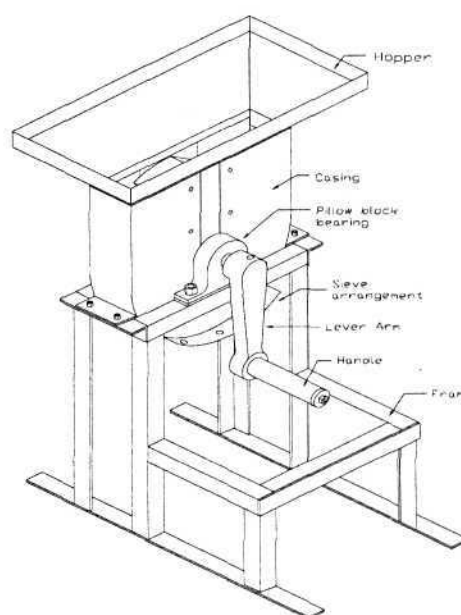


Figure 2.1-Diagram of Weaning Food Processing Equipment

2.1 Design Description

The dimension of these components were selected/ computed by adopting the following design procedure.

1. Considering maximum space required for a batch size of weaning food under design condition, dimension of casing and hopper were selected.
2. Size of the beater was selected according to the inside dimension of the casing.

3. Maximum torque that can be applied by a human on an average was taken into account for strength calculations.
4. Size of the shaft was calculated by using relevant formulae.
5. Considering nearest available values of the material and also the available facilities for fabrication, the dimension of the components were selected in the design of the equipment.
6. Materials were selected for a hygiene design.
7. Various components of the equipment were designed with the help of the standard relations in a Text Book of Machine Design (Khurmi and Gupta, 1993).

2.2 Casing and Hopper

The dimension of the casing and hopper basically were selected by considering the maximum weaning food batch size of the 4000 cm³ at a time. The capacity of the extraction chamber is 3000 cm³. Casing consists of two parts. The bottom part is a hemi cylindrical section with 125mm radius and 62.5mm height. And a right box section with a cross sectional dimension of 200mm x 62.5mm and 137.5mm height is fitted to hemi cylindrical section. The dimension of the hopper bottom 246mm x 60mm was selected, as it can be fitted to the top of the casing. Hopper plates angle were kept at 45° to the horizontal in all four sides. Dimension of the hopper top section was 371mm x 185mm. The total vertical height of the hopper was 87.5mm. Vertical height of slanted hopper section was 62.5mm. The casing and hopper were fabricated using a 14 BWG (2.1mm) SS- 304 sheet from hygienic point of view. SS-304 does not react with the foods even the food is of acidic nature.

2.3 Dimension of the arms of the beater

The cross section of the arm is obtained by considering the arm as cantilever i.e., fixed at the shaft end and carrying concentrated load at the blade end. The length of the cantilever is taken equal to the radius of the beater. It is further assumed that at any given time, the power is transmitted from shaft to the blades of the beater through only half of the total number of arms.

Tangential load per arm is given by following equation [Khurmi and Gupta, 1993]

$$W_T = \frac{T}{R \times \frac{n}{2}} = \frac{2T}{R \times n}$$

Where,

T= Torque Transmitted

R=Radius of beater blades rotating circle

n=Number of Arms,

So, Maximum bending moment on the arm at the shaft end

$$M = \frac{2T}{R \times n} \times R = \frac{2T}{n}$$

Section modulus of Arm

$$Z = \frac{1}{6} t_A \cdot B_A^2$$

Where,

t_A= thickness of the arm

B_A= width of the arm

Since $f_b = \frac{M}{Z}$, substituting M & Z, we get

$$f_b = \frac{2T}{n} \times \frac{6}{t_A \times B_A^2} = \frac{12T}{n \times t_A \times B_A^2} \dots (c)$$

$$T = P \times L = 40 \times 9.81 \times 150 \text{ Nmm} = 58860 \text{ Nmm}$$

For arm material $f_b = 70 \text{ N/mm}^2$,

Taking; n=4, R=100mm and assuming B_A=2 t_A

Substituting these values in equation (c)

$$70 = \frac{12 \times 58860}{4 \times t_A \times 4 \times t_A^2}$$

Simplifying, t_A = 8.58mm

Take t_A = 9mm

So B_A = 18mm.

2.4 Beater Blade

The width of the blade (60mm) was selected according to the width of the casing. The total length of the beater was 113mm. This comprises of a 53mm long curved section with 124mm radius and 60mm long rectangular section and this rectangular section was bended to an angle of making 35° making with the tangent drawn to the curved surface at the connecting line of these two curved and rectangular surface. A plate having rectangular cross section 113mm x 60mm was bended to these two curved and angular shapes. The beater was welded to curved part of the beater blade at the middles of the width of the blade, starting from the connecting line of the curved and angular flat section. This is shown in Fig.2.2.



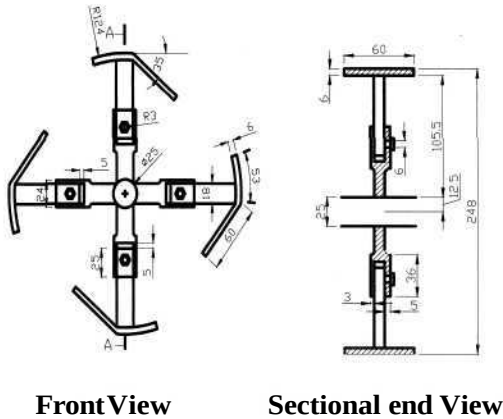


Fig. 2. 2: Beater

In designing, the length of the beater blade was assumed such that every time one beater blade is in action in the 180mm long curved sieve which was fitted to the bottom of circular casing. The thickness 6mm of beater blade was calculated according to the strength of the blade material SS-304. In calculation of the blade thickness, it was assumed that at any given time the power is transmitted from shaft to the blade of the beater through only half the total number of blades. The total tangential force on the handle was assumed as 392N.

2.5 Handle

The handle was fabricated by using a cylindrical solid nylon bar having diameter of 32 mm and length of 100 mm (Fig. 2.3). A hole diameter 8mm was drilled throughout the length of this solid nylon bar and a rod (dia - 8mm, 120mm long, SS-304) passing through this hole was used to fix the handle to lever arm. Nylon handle can rotate freely on the rod while operating equipment. In designing the handle, it was assumed that the effort applied on the handle acts at the mid point of it. In calculation the length of the handle was assumed as 100 mm and diameter of the handle was calculated according to the strength of the nylon material. Maximum force on the handle and permissible bending stress of nylon were taken as 392N and 20.75 N/mm² respectively.

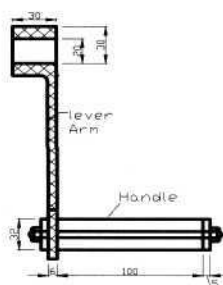


Fig.2. 3: Handle

2.6 Lever Arm

Lever arm was used for transmission of power from handle to the shaft. Lever arm comprises of a collar in both ends for connecting to shaft and handle having uniform thickness throughout. The width of the lever arm was tapered from shaft side to the handle side. The inside diameter of the collar in shaft side selected according to the shaft diameter and similarly inside diameter of the collar in handle side was selected according to the diameter of the handle.

In designing, length of the arm was assumed and the collar dimensions were selected according to dimensions of the shaft and handle. The thickness of the lever arm was selected according to the strength values of the lever arm material. In calculation, width of the lever near the collar in shaft side was taken as twice the thickness of the lever arm.

2.7 Design of shaft

The beaters were welded to a shaft made up of SS-304. The shaft was mounted on a frame with the help of two pillow block bearings. The power is transmitted from the handle to shaft by using the lever arm. The total length of the shaft is 157.5mm.

(I) Assuming the shaft is subjected to twisting moment or torque only

The bending formula

$$\frac{T}{J} = \frac{f_s}{r}$$

Where,

T = Twisting moment (Nmm)

r = Distance from the neutral axis to the outermost fiber (mm) (i.e. d/2; where d is the diameter of the shaft),

J = Polar moment, Where, $J = \frac{\pi}{32} \times d^4$

fs = Torsional shear stress (N/mm²)

Substituting value of polar moment

$$T = \frac{\pi}{16} \times f_s \times d^3 \quad \dots (1)$$

So, the diameter of the shaft (d) is,

$$d = \left(\frac{16T}{\pi \times f_s} \right)^{3/1}$$

Length of the lever arm is 150mm

Taking the maximum force on the handle as 392.4N (40kgf)

Taking torsional shear stress (fs) as 62 N/mm² for SS-304

Substituting values in equation (1)

$$T_{\max} = 392.4 \text{ N} \times 150 \text{ mm} = 392.4 \text{ N} \times 150 \text{ mm}$$

$$= 58860 \text{ Nmm}$$

$$58860 = \frac{\pi}{16} \times 62 \times d^3$$

$$d = 16.91$$

Select $d = 17 \text{ mm}$

(II) Assuming the Shaft is subjected to combined twisting moment and bending moment

Hence;

(a) According to the maximum shear stress theory simplified equation

$$\tau_e = \sqrt{\tau_s^2 + \frac{1}{4} \sigma_s^2} = \frac{\pi}{16} \tau_s \times d^3 \quad f$$

.....(a)

(b) According to the maximum normal stress theory, simplified equation

$$\sigma_e = \frac{1}{2} \left(\sigma_s + \sqrt{\sigma_s^2 + 4\tau_s^2} \right) = \frac{\pi}{32} \sigma_s \times d^3$$

..... (b)

Where,

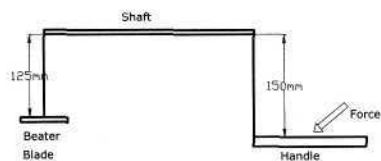
T = Twisting moment (or torque) (N-mm)

M = Bending moment (N-mm)

τ_s = Shear stress induced due to twisting moment (N/mm²)

σ_s = Bending stress (tensile or compression) induced due to bending moment (N/mm²)

Maximum Tangential force on the beater blade ($F_{\max}$)



Equating the torque

$$F_{\max} \times 125 = 392.4 \text{ N} \times 150$$

$$= \frac{6}{5} \times 40 \times 9.81$$

$$F_{\max} = 470.9 \text{ N}$$

Due to this force, bending moment (M) of the shaft (neglecting the thickness of the blade)

$$M = 490.9 \text{ N} \times 125 \text{ mm}$$

$$M = 58860 \text{ Nmm}$$

Torque (T) of the shaft

T = Force on the handle x Length of the lever arm

Taking the Maximum Force on the handle as 392.4 N

$$T = 392.4 \text{ N} \times 150 \text{ mm}$$

$$T = 58860 \text{ Nmm}$$

Substituting T & M values in equation (a)

$$\sqrt{58860^2 + 58860^2} = \frac{\pi}{16} \times 62 \times d^3$$

$$d = 18.98 \text{ mm}$$

Substituting T & M values in equation (b)

$$\frac{1}{2} \left(58860 + \sqrt{58860^2 + 58860^2} \right) = \frac{\pi}{32} \times 70 \times d^3$$

$$d = 21.78 \text{ mm}$$

Considering all the above cases, diameter of the shaft was selected as 25mm.

2.8 Sieve Assembly

Sieve assembly consists of a sieve, supporting frame for sieve and fixing plate. This total unit was fitted to the bottom of the casing in operation. Sieve was fabricated by using a wire mesh with mesh number 16 and made of SS-304. The sieve has a rectangular dimension of 180mm x 112.5mm and a frame with 8mm width and made of SS-304 is fixed to the wire mesh.

2.9 Frame

The equipment is mounted on a rigid frame made of SS-304. The rectangular dimensions of the frame were selected according to the dimensions of the casing, handle and considering easy operation of the equipment. The thickness of the frame materials were calculated according to the load acting on frame. Such as weight of the equipment itself, weight of the food and forces imposed on the frame by human hands while operating the equipment etc. The availability of materials and facility for fabrication were also considered for final selection of materials. The equipment has a frame of overall dimensions 440mm x 250mm x 397mm, fabricated from angle (25 x 25 x 3 mm) and flat (25 x 3 mm), SS-304 sections. These sections were jointed by electric arc welding.



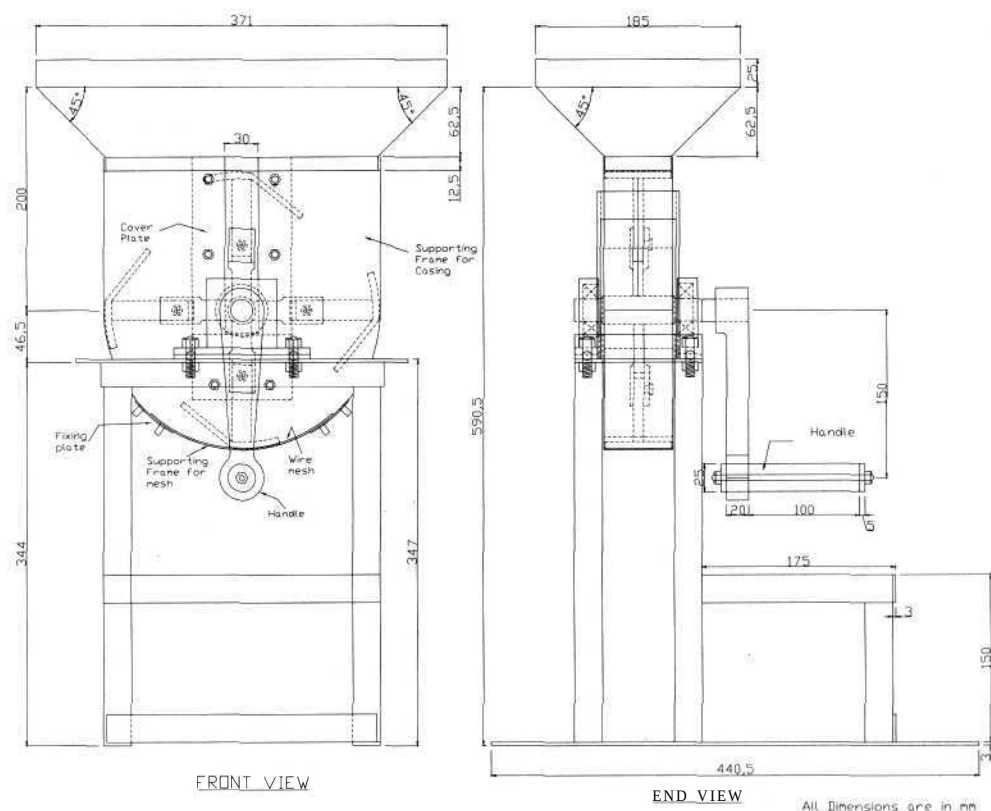


Fig. 2.4: Front and end view of Weaning Food Processing Equipment

3. Materials and Methods

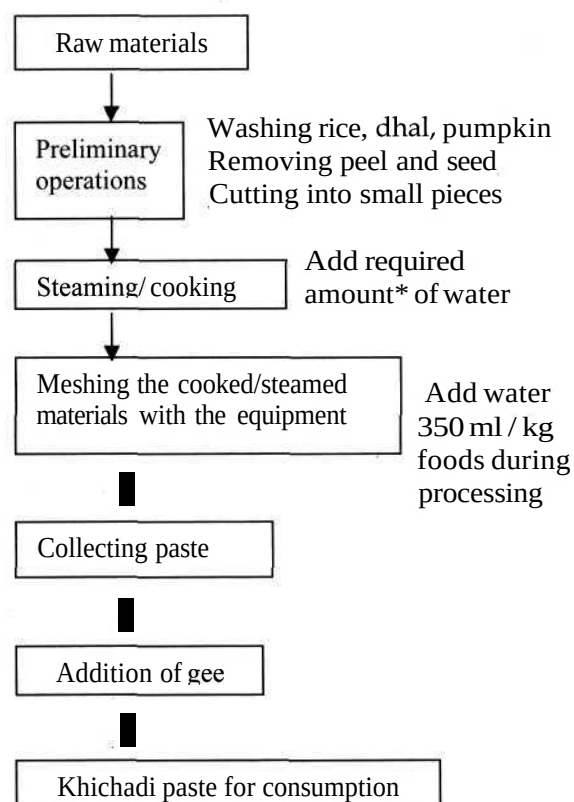
Weaning food processing equipment was tested with one food item, called khichadi which is generally used as home made weaning food. The recipe used for preparing khichadi and the process which was followed to prepare khichadi paste are presented below. The equipment produces paste from khichadi. Prepared khichadi was meshed and changed into paste form by using the developed equipment taking three different batch sizes (2,3 and 4kg) and three replications with each batch. The performance of the equipment was evaluated with regards to the time taken for a batch operation (extraction), power requirement, extraction efficiency and properties of the final product such as viscosity, moisture content and density.

Recipe of Khichadi

- | | |
|---------------------------------|------------|
| 1. Rice | 10 g |
| 2. Green gram Pulse (de-husked) | 10 g |
| 3. Ghee | 5-10 g |
| 4. Pumpkin | 20 g |
| 5. Tomato- (puree) | 10 g |
| 6. Dry Spinach powder | 2 g |
| 7. Water | 50 - 60 ml |
| 8. Salt | 1 g |

Source: Sharma and Jain (2000)

Process flow chart of preparing weaning



3.1 Performance Evaluation of weaning food processing equipment

* As mentioned in the recipe

3.1.1 Time taken for a batch Extraction

The time taken for a batch extraction was measured in terms of the time required to mesh a batch of cooked/ steamed foods into paste form through the developed equipment. The total time (Including feeding time) for meshing was noted. The time taken for batch operation of equipment as expressed as minutes required per batch i.e. min / batch.

3.1.2 Extraction efficiency

Extraction efficiency was determined by the following expression [Kazembe, 2005]

$$\text{Extraction Efficiency} = \frac{\text{Quantity of extracted paste}}{\% \text{ pulp content} \times \text{sample size}}$$

3.1.3 Power requirement

Power requirement was determined by the following expression [Kazembe, 2005]

$$\text{Power} = \frac{\text{Food quantity} \times \text{handle movement}^{**}}{\text{Extraction time}} \times g$$

3.2 Properties of the final product

Properties of the final product were measured in terms of the moisture content, density and viscosity.

3.2.1 Determination of moisture content

The moisture content of weaning paste was measured by using the vacuum oven method [Rangana, 2000]. A vacuum oven having digital control system was used for determination of the moisture content of the weaning paste. Moisture content of khichadi paste is expressed in % wet basis. A sample of 20-30 g of paste was dried to an apparent dryness in a vacuum oven at 70°C at a pressure of 400 mmHg and then vacuum pressure was reduced to 90 mmHg. The sample was dried under this condition, was cooled in a desicator and the final weight was measured. Experiment was continued until a constant weight was obtained. The weight reduction is expressed as percentage to the initial weight.

3.2.2 Density Measurement

Density of the weaning paste was measured by measuring the volume of a sample with known mass. Two electronic weight balances one having capacity 200g with least count 0.001g for fine measurement and another having capacity of 5kg with least count 0.5g for bulk measurement were used for weighing of the paste for evaluating the density etc. Measuring Cylinders having capacity of 1000, 500, 250 cm³ were used for measurement of

volumes. Density is given by following expression.

Amount of paste = m_1 (g)

Volume of the same sample = V_1 (cm³)

$$\text{Density of the paste} = \frac{m_1}{V_1} (\text{g/cm}^3)$$

3.2.3 Viscosity Measurement

Viscosity is the resistance to flow indicated by coefficient of viscosity. Viscosity coefficient of weaning paste was measured by using the rheometer (Model: CSL²100) and expressed in terms of Pa.s. A geometry having 4 cm steel plate was fixed to the equipment. Sufficient amount of sample was loaded to the peltier plate and equipment was operated with zero gap for measuring viscosity. Viscosity was measured for the range of shear stress for up flow 100-200 Pa, for hold flow 200 Pa and 200-100 Pa for down flow. The curves of shear stress (Pa) Vs Shear rate (1/s), which were obtained from the computerize rheometer were used for taking the reading of viscosity.

4. Results and Discussion

Fig.4.1 is the variation of extraction time with different batch size. It shows that the extraction time increases with increase in the sample size which is obvious. Fig.4.2. is the variation of extraction time for unit food quantity with different batch size. It shows that extraction time for processing unit food quantity decreases with the increase in the batch size. When batch size is increased from 2kg to 4kg, it is observed that a reduction of 18.3% of extraction time for unit food quantity. Hence in full load condition (4kg) it is required 2.12 min to process 1kg of food. The decrease in the extraction time with increase in batch size is due to the increase of pressure on the food on the sieve when increase the amount of food.

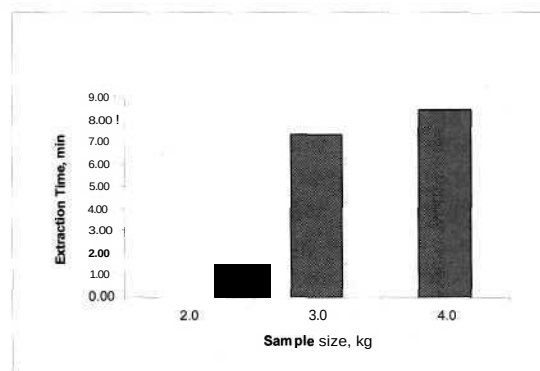


Figure 4.1-Variation of Extraction time with batch size

* Handle circumferential distance

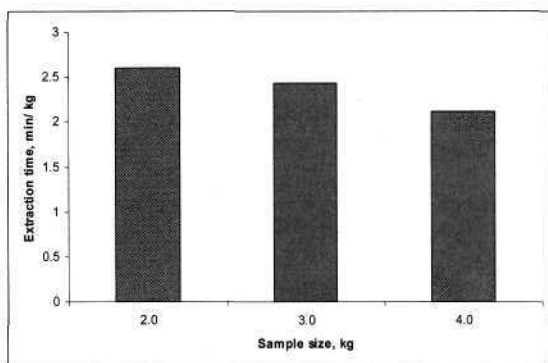


Figure 4.2-Variation of Extraction time for unit food quantity

Fig.4.3 is the variation of extraction efficiency of the equipment with different batch size assuming the pulp content of the cooked *Khichadi* as 100 per cent. It shows that the extraction efficiency increases with increase in batch size. Extraction efficiency increases from 92.53% to 94.48% with increase in sample size from 2 to 4kg.

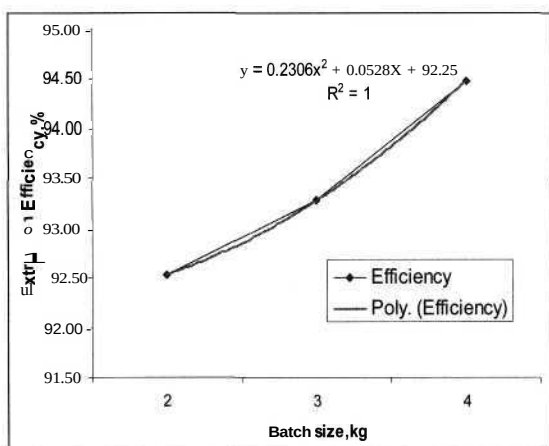


Figure 4.3- Variation of Extraction Efficiency with batch size

The average power requirement of the developed weaning food processing equipment has been observed to be about 0.073W, when operated by using 4kg batch size at a time. Fig.4.4 is the variation of the power requirement of the developed equipment with different batch size. It shows that the power requirement increases with increase in batch size. Fig.4.5 is the variation of the power requirement for unit food quantity with different batch size. It shows that power required for processing a unit food quantity decreases with the increase in the batch size. When batch size increased from 2kg to 4kg, there is a reduction of 38.1 per cent in power requirement for processing 1kg of food. The decrease in power requirement for processing of 1kg food material with increase in batch size

is due to the reduction of extraction time with increasing batch size.

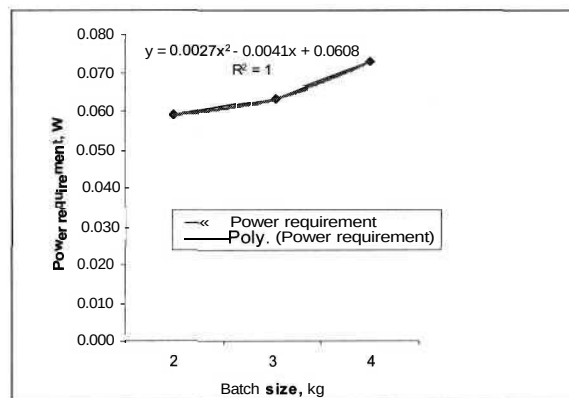


Figure 4.4-Variation of power requirement with batch size

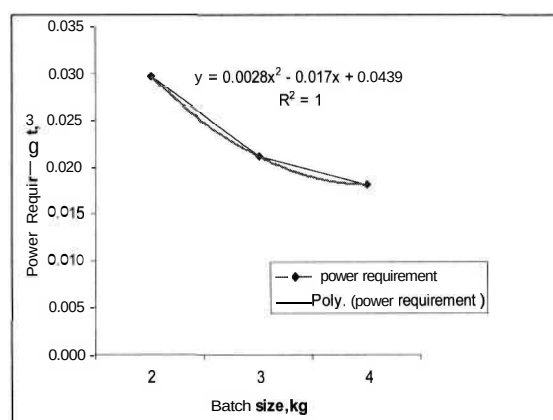


Figure 4.5-Variation of power requirement for unit food quantity

Properties of the final product were measured in terms of moisture content, density and viscosity. It was found that the average moisture content, density and viscosity for the weaning paste produced with the developed equipment were 81.5 per cent, 1030 kg/m³ and 4.431 Pa.s respectively.

5. Conclusions

1. The average time taken for processing a food batch (4kg) was estimated to be about 8.47min. The extraction time for processing a unit food quantity decreases with the increase in the batch size.
2. The extraction efficiency of the developed equipment was found between 92.53 and 94.48 per cent and it increases with increase in batch size.
3. The average power requirement of the developed equipment has been observed to be about 0.073W, when equipment was operated with batch of 4kg at a time. The power

required for processing a unit food quantity decreases with the increase in the batch size.

4. It was found that the average moisture content, density and viscosity for the weaning paste produced with the developed equipment were 81.5 per cent (wb), 1030 kg/m³ and 4.431 Pa.s respectively.

References

1. Anonymous., Workshop on Practical Considerations for Child feeding in East, Central and Southern African Countries, 1981 Arusha, Tanzania.
2. Hendrick, K.M., & Badruddin, S.M., Weaning Recommendations: The scientific basis Nutrition Reviews, 1992,50(5):123-125.
3. Kazembe, H.W., Approaches to Successful Development of Low-Cost Fruit Juice Extraction Technologies: A Case Study to Improved Rural Livelihood in Malawi, Tropentag, Stuttgart-Hohenheim, 2005, pp 3.
4. Khurmi, R.S., & Gupta, J.K., A Text Book of Machine Design, 2nd ed., Eurasia Publishing, New Delhi, 1993 pp. 429-467.
5. Mitchell, R.G., Child life and Health, 5th ed., J & A Churchill, Pitman Press, London, 1970, p132-135.
6. Ranganna, S., Handbook of Analysis and Quality Control for Fruits and Vegetable products, Tata McGraw Hill Publishing Co. Ltd, New Delhi2000, pp 3.
7. Scrimshaw, N.S., & Wallerstein, M.B., Nutrition Policy Implementation Issues and Experience. Plenum Press, 1982, pp. 101-146.
8. Sharma, S., & Jain, S., Nutrition of Infant: Some important things Apna Patra, Annual Issue, Sanchara Kandra, MPUAT, Udaipur, 2000, p 63.
9. Tackett, J.J.M., Family-Centered Care of Children and Adolescents, Nursing Concepts in Child Health, W.B Saunders Company, 1981, pp 465-471.
10. WHO/ UNICEF, Infant and young child feeding current issues, Report of an expert Group,1981.



Figure 5-Developed Weaning Food Processing Equipment

