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RESEARCH ARTICLE

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Nutrient dense cereal pulse mix for enteral feeding

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ABSTRACT

The aim of this paper is to analyse nutrient composition and selected quality parameters like viscosity, osmolality, and caloric density of an easily reconstitutable nutrient dense mix used for enteral feeding. Simple indigenous technology using natural ingredients was employed for formulating the mix. Quantitative analysis of both the macro and micro-nutrients was carried out and it was found that 100g of the formula provided 385 kcal and 39.53 g of protein. 30 g of flour after reconstitution with milk provided 428 kcal and 19.8 g of protein. The viscosity of the enteral feeds in one per cent solution was reported to be 250 centiposes as against recommended 60 centiposes for commercial formulas. The osmolality was found to be 339 mOsmol/kg, which was within the recommended range of osmolality (270-770 mOsmol/kg) for enteral feeding. The caloric density of the formula was 0.82kcal/ml. These preparations would provide nutritional support at relatively lower cost compared with commercial formulations for varied clinical conditions without compromising quality. These mixes would be beneficial for enteral feeding in developing countries as a viable alternative for commercial formulations, which tend to be expensive.

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Key words : Nutrient dense, Cereal pulse mix, Nutrient composition, Caloric density

INTRODUCTION

Malnutrition is prevalent to a higher degree among hospitalized patients throughout the world (Torosian, 1999). As many as 40% of adult patients are seriously malnourished at their hospital admission and two thirds of all patients experience deterioration of their nutritional status during their hospital stay.

A nutritionist's role in the hospital is to formulate the most appropriate nutritional therapy for each patient based on their nutritional status. There are varied nutritional intervention strategies to choose from which includes natural foods, nutritional supplements, enteral tube feeding and partial or total parenteral nutrition. In situations, where oral intake is not possible and the gastrointestinal tract is functioning, nutrients can be provided via feeding tubes placed into the alimentary tract. Enteral nutrition by tube has been used since the late 1800's. For years enteral formulae were prepared using foodstuffs, vitamin and mineral preparations and a blender. Today an extensive variety of commercially prepared formulae are used. Some formulae are nutritionally complete, some are formulated for specific diseases or conditions, and others (modular) provide specific nutrients to supplement a diet or other formulae (Grodner, 2007)

Commercial, ready-to-use formulae have been available for over 20 years and they are the most preferred formulae for enteral nutrition support in developed countries (Tanchoco, 1990). Studies have documented that commercial formulae have uniform contents and are associated with less mechanical complication such as tube clogging, it is prepared in an aseptic environment and are sterile which greatly reduces the risk of gastrointestinal complications such as diarrhea, abdominal distention and constipation and it is cost effective in terms of overall management and recovery of the patients (Sullivan, 2001).

Home based intact polymeric formulae have been assumed to be inferior to commercial formulae. Using simple indigenous technologies easily reconstitutable home based nutrient dense mixes containing natural food ingredients are now being developed in developing countries for enteral feeding. These mixes are prepared using various combinations of malted cereals and pulses along with nuts and condiments. They are analyzed for nutrient composition and selected quality parameters. These mixes provide nutritional support at relatively lower cost compared with commercial formulations for varied clinical conditions. These mixes would be beneficial for enteral feeding in developing countries in lieu of commercial formulations, which tend to be expensive. Many institutions prefer the use of cereal pulse based home made enteral formula. This preference may result from believing them to be more "natural" (physiologic) or more economical. Although they are cheaper, home based formulas are also more time consuming. Extra time is needed to make sure that sanitary methods are used to prevent contamination of the formula (Udipi, 2006).

However, it should be kept uppermost in mind that there are also population who are not in a position to afford even a single meal per day. A study done by Parikh et al (2003) showed that their study population had just Rs.1000/- per month for the family meal. In such situations use of expensive commercial formulas is a challenging aspect and at the same time these patients cannot be deprived of nutritional support. In our country people from low socio-economic group face difficulty in buying expensive commercial formulas, low cost indigenous cereal pulse based enteral formulas are presumed to be the best in meeting their nutritional requirements.

Therefore, the present study was undertaken to develop an indigenous cereal pulse mix enteral feeding formula which would suit the needs of the critically ill while being at an affordable cost and safe for enteral use.

Objectives :

This study was conducted to determine the quality of a home based intact polymeric formula (blenderised formula) in terms of the following:

- Nutrient composition
- Viscosity, osmolality and
- Caloric density

MATERIALS AND METHODS

The raw ingredients for the cereal pulse intact polymeric formula were selected using the nutrient composition table (ICMR standards) to complement each other in their respective limiting nutrient. The chosen grains were then processed to improve the amylase rich factor which would help in improving the viscosity of the formula as well.

Nutrient analysis :

Knowledge on the nutrient composition of an enteral formula is important for the selection of the formula and in its effective utilisation. The chemical composition and physical properties of foods are used to determine the nutritive value, functional characteristics, and acceptability of the food product. It is also an important step in formulating and developing new products, Macro and micronutrients such carbohydrates, protein, fat, fibre, calcium, iron, sodium, potassium and vitamin C are useful in clinical practice. Hence, the developed formula was subjected to evaluation of its physical characteristics and nutrient composition. The details of the composition of the home based intact polymeric formula is presented in Table 1.

Table 1 : Intact polymeric formulae composition

Cereals	Pulses	Condiments	Nuts
Wheat	Bengalgram	Ginger	Groundnuts
Bajra	Black gram	Elaichi	
Barley	Green gram	Nutmegs	
Corn	Horse gram		
Ragi	Soya beans		
Riceflakes	Sago		

Standardization of home based intact polymeric formulae:

Standardisation is the process of developing and agreeing upon technical standards. It was essential to standardise the home based intact polymeric formulae to ensure nutrient density and uniformity of preparation before being dispensed to the patient. Based on the results obtained regarding the nutrient composition of the intact polymeric formulae, the formulae was standardised using the following combinations as presented in Table 2.

Table 2 : Standardization of intact polymeric formulae

Sample	Flour (g)	Milk (ml)	Water (ml)	Sugar (g)	Oil (ml)
1	30	250	300	25	5
2	35	200	350	25	5
3	40	150	400	25	5

A trial flow check was performed to check the free flow of the formulae with different reconstituted concentrations. The formulae was transferred to the feeding set which is generally designed for gavage or gravity feeding in the intensive care unit. Feeding bags or containers were attached to spike sets which contain a pin at the proximal end of the set that pierces the container. A Ryles tube of 16 French which is normally used in adults for enteral feeding was then attached to the other end of the spike set. A roller clamp regulated the formulae flow in the delivery sets.

Sample 1 which contained 30gm of flour was seen to flow through the tube better than Sample 2 without clogging the Ryles tube. This sample one, with 30gm flour was then chosen as the final standardized formulae to be administered to the patients on tube feeding.

Physical characteristics:

Once a formulae has been selected for patient's use based upon nutritional requirements and gastrointestinal function, there are certain physical characteristics of formulae that may affect tolerance. The major symptoms of tube feeding intolerance are gastric retention and diarrhoea or constipation. These symptoms are often related to the formulae itself and may be the result of inappropriate administration techniques or drug interactions. They may also be due to intolerance to some characteristic of the formulae such as osmolality, caloric density and viscosity (Rombeau, 1997).

Osmolality:

One of the most important physical characteristics of a formulae is its osmolality. It is the function of size and quantity of ionic and molecular particles (protein, carbohydrate, electrolytes, and minerals) within a given volume (Rombeau, 1997)**.**Osmolality of Enteral support formulas range from 270 – 700 mOsmol/kg (Matresse, 2008).

Osmolality of Enteral support formulas should be determined before administering it to the patients to prevent any intolerance. Hypertonic formulas may cause gastric retention, nausea and vomiting. It may even affect the solute load and water requirements within the body as well. (Rombeau, 1997).

The osmolality of the intact polymeric formulae was determined using an osmolalometer in a biochemistry Laboratory.

Viscosity:

It is a measure of the resistance of a fluid which is being deformed by either shear stress or extensional stress. Enteral formulas of greater viscosity may lead to tube clogging (Rombeau, 1997). The viscosity of the intact polymeric formula was determined using a Viscometer in a biochemistry Laboratory as per the standardisation techniques.

Caloric density:

Caloric density may affect the patient's tolerance of tube feeding by its affect on gastric emptying. The greater the caloric density, the slower the emptying rate into the duodenum (Rombeau, 1997). Hence it should be determined before administering it to the patients to prevent any intolerance. It was calculated as the amount of calories provided by per millilitre of the feed**.**

RESULTS AND DISCUSSION

Nutrient composition of the intact polymeric formula is presented in Table 3. The intact polymeric formulae was found to provide 385 kcal and 39.53 g of protein per 100 g. It contained germinated cereals, pulses, nuts, condiments and herbs which met 100% RDA for all macro and micro nutrients. The fibre content helps in bowel regulation. It imparts Amylase Rich Factor (ARF) thereby improving the digestibility.

Table 3 : Nutrient composition of intact polymeric formulae

Approximate composition	Unit	Per 100 g of IPF
Energy	Kcal	385
Protein	g	39.53
Fat	g	6.54
Fibre	g	2.67
Carbohydrates	g	41.67
Calcium	mg	80.78
Sodium	mg	11.21
Potassium	mg	9.75
Iron	mg	0.83
Vitamin C	mg	23.33

Nutritional composition of intact polymeric formula after standardisation is presented in Table 4. The intact polymeric formulae after reconstitution gave 428 kcal and 19.859 g of protein

Physical characteristics:

The physical characteristics of the intact polymeric formulae are as presented in Table 5.

Caloric density:

The caloric density of the intact polymeric formulae was 0.82 kcal/ ml as against commercial formulae which provide 1kcal/ml.

Viscosity:

The viscosity of the intact polymeric formulae in 1% solution was reported to be 250 centiposes. However, there was no problem encountered in the flow of the intact formulae into the Ryles tube such as tube clogging, as the ingredients used in the formulae were germinated which

Table 4 : Standardized nutritional composition of intact polymeric formulae

Ingredient	Amt (g)	Energy (Kcal)	Protein(g)	Fat(g)	CHO (g)
Flour	30	1155	11.859	1.962	12.501
Milk	250	167.5	8	10	10
Water	300	-	-	-	-
Sugar	25	100	-	-	25
Oil	5	45	-	5.0	-
	500ml	428 kcal	19.859 g	16.962g	47.501g

Table 5:Physical characteristics of intact polymeric formulae

Physical characteristics	Values
Caloric Density (kcal/ ml)	0.82 kcal/ ml
Viscosity (centiposes)	250 centiposes
Osmolality (mOsmol/kg)	339 mOsmol/kg

impart amylase rich factors that help to reduce the density and enable a free flow through the tube. Moreover, the formulae was blenderised thoroughly with care taken to avoid any formation lump and thereby preventing tube clogging.

Osmolality:

The osmolality of the intact polymeric formulae was found to be 339 mOsmol/kg. The osmolality of the formulae was within the recommended range, to avoid any gastro-intestinal complication.

Conclusion:

Under the prevailing economic conditions of the country and health care systems, it is wiser to make use of indigenous home based formulae in providing adequate nutrition support for those critically ill people, who are not in a position to afford costly health care services. Sufficient care is taken to design its content, use of non- viscous particulate free foods and maintain the strictest hygiene. It is suitable for all ages from infancy to geriatrics, pre and post operative nutritional support. It is a solution for poor oral intake. It can be used both as supplemental and total meal replacement.

Other indications:

– Can be used for both adults and children (above 1 yr.) as a regular health drink.
– Can be used for infants (above 2 months) as a supplementary to the mother's milk and weaning food in diluted condition. (should be sieved and thoroughly mixed)
– Can be used as a supplement (4 times a day) to III patients
– Can be used for diabetic patients without adding sugar and mixed in skimmed milk thereby it is cutting down the carbohydrates to 55%;
– Can be used for heart patients in which case provides only 6% fat when mixed in skimmed milk.

However, the implementation of nutrition support using such formulae require meticulous planning, administration and monitoring as per the enteral nutrition support protocols, with the involvement of a multi-disciplinary team approach. The role of the nutritionist in this surveillance is thus of paramount importance.

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