Formulation Of Standard (Nutriagent Std) And High Protein (Nutriagent Protein Plus) Ready To Reconstitute Enteral Formula Feeds

Kavita Sharma, Ila Joshi

Abstract: The objective of this study was to formulate two ready to reconstitute (RTR) enteral formula feeds with whole some nutritional approach and ease of administration. A cohesive survey work was done to collect the information about commercially available enteral formulas as well as 'home made' blenderized feeds preferred by some medical institutions. On the basis of the gathered information, few food ingredients from the basic food groups were selected and analyzed for their nutritional values by using standard analytical techniques. Various trials of the processing techniques were carried out in the laboratory to achieve the feasible digestibility as well as shelf life qualities in the developing feeds. The RDA of a reference man was taken as a basis to formulate the standard **(Nutriagent Std)** and High Protein **(Nutriagent Protein Plus)** Ready to Reconstitute Enteral Formula Feeds. The first standard feed **(Nutriagent Std)** was estimated to deliver about 2000 kcal energy and 75 g protein (15% of total energy content) from the total amount of the feed (490g). The percentages of major energy constituents i.e. total carbohydrates and fats were accounted as 278 g (53% of total energy content) and 65 g per (30 % of total energy content) from the total feed. The micro nutrient levels of the sample were detected to be sufficient in amount. The second high protein feed **(Nutriagent Protein Plus)** was intended to possess high protein along with the sufficient amount of energy for protein sparing. The 530 g sample of this feed was fabricated to supply 2004 kcal energy and 101 g protein (20% of total energy content). The carbohydrates and fat contents were found as 257 g (50 % of total energy) and 67 g (30% of total energy) from the total feed. The micro nutrient composition was also found to be sufficient in the feed sample. The developed feeds were checked for their reconstitution behavior, pH as well as their flow behavior through Ryle's tube. The shelf life quality of the developed formula feeds were also checked for the period of 90 days on the basis of the nutritional parameters like moisture and peroxide value and microbial parameters like total viable count, coliform count and fungal count. All the parameter were found in the favour of the developed products. Thus the present study speculates that both formulated RTR enteral formula feeds would render appreciably the whole some nutrients to the patients' dependent upon enteral nutrition system for long time. Additionally, it would minimize the chances of microbial contamination and reduce the efforts to prepare the feeds.

Index Terms: Enteral formula feed, Blenderized diet, RTR (Ready to Reconstitute), Shelf life, Macro nutrients, Micro nutrients, Reconstitution behavior.

1 INTRODUCTION

Nutritional support is a vital component of medical care. Enteral nutrition (EN), the provision of nutrients via the gastrointestinal (GI) tract through a feeding tube, catheter or stoma, is the preferred route for the provision of nutrition for patients who cannot meet their nutrition needs through voluntary oral intake. This type of feeding provides many physiologic, metabolic, safety, and cost benefits over other methods of feeding. (Lois Ahrens 1989). According to Reshma Nilesh (2011) the best way to feed a patient is using their own gastrointestinal tract (stomach and bowel). Those patients who can not swallow food due to a breathing tube inserted in the throat, they are fed through a feeding tube. The major indicators of the enteral nutrition are the symptoms like Unconscious, Neuromuscular swallowing disorders, Physiological anorexia, Upper gastrointestinal obstruction , Gastrointestinal dysfunction / malabsorption, Increased nutritional requirements, Psychological problems and Specific treatment e.g. for Crohn's disease **(NICE 2006).**

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The A.S.P.E.N. Nutrition Support Practice Manual (2nd Edition 2005) has reported that enteral nutrition system can be classified in two categories: one is **short term nutrition** system which lasts for less than 4 weeks at acute stage of disease (nasogastric, nasoduodenal and nasojejunal tube feeding) where as the second is **long term enteral nutrition system** which lasts longer then 4 weeks at chronic stage of disease (gastrostomy and jejunostomy). Mode of delivering feed can be decided according to the needs of the patient. Relatively large amount of formula can be delivered for several times per day (**intermittent feeding**) or smaller amounts continuously during the day **(continuous feeding**). A patient may also start with continuous feeding and gradually transition to intermittent feeding. Enteral feeding can be classified in different ways. A classification is based on the practical considerations according to the clinical indications for the solution .**Mahan et. al, 2000** has classified the enteral formula feeds as

1. Blenderized feeds, which are prepared from milk ,beef, fruits , vegetables and fiber. Patients who use enteral feeding at the house hold level can prepare blenderized feed from regular foods with simple processing techniques.

2. Polymeric food solutions: These solutions contain macronutrients in the form of isolates of intact protein, triglycerides and carbohydrate polymers, which can be used through a tube and can provide complete nutrition. These can be categorized as follows:- ♦**Standard adult formulae** They provide 1 kcal/ml and are suitable for the majority of patients. They are available with and with out fiber. . ♦**High energy adult formulae** These provide 1.2 to 2 kcal /ml and are useful for patients on fluid restriction or with increased nutritional requirements such as burn patients. ♦**Disease specific**

enteral formulae :- like renal feeds , low sodium feeds respiratory feeds , Immune feeds etc. (Heys et al1999.

3. Monomeric solutions:- These solutions usually contain proteins as peptides and /or amino acids , fat and long chain triglycerides or mixture of LCTs (Long chain triglycerides) and MCTs (Medium chain triglycerides) and carbohydrates as partially hydrolyzed starch , maltodextrin glucose or oligosaccharides. .

4.Solutions for specific metabolic needs:- These nutritional solutions are intended for patients who have unique metabolic requirements- Inborn error of metabolism , renal failure , hepatic failure etc.

5. Modular solutions:- Solutions which contain nutritional components that can be given by themselves or can be mixed with other enteral products to meet special nutritional or metabolic needs of a given patient like increased calories, increased minerals etc.

6.Hydration solution:- Solutions which provide minerals , water and small amounts of carbohydrates. (Alexander jw JPENJ parenter Enteral Nut 1990; 14:170S-4)

When selecting an appropriate enteral formulation both formula characteristics and patient-specific factors should be considered. Formula variables include: digestibility/availability of the nutrients, nutritional adequacy, viscosity, osmolality, ease of use, and cost. Patient variables include: nutritional status and requirements, electrolyte balance, digestive and absorptive capacity, disease state, renal function, medical or drug therapy, and possible routes available for administration. Adult enteral formula products fall into one of the following categories: general use, high nitrogen, high nitrogen and high calorie, fiber enriched, semi-elemental, fat modified, and specialty. The choice of nutritional supplementation depends on the degree of inability to meet nutritional needs by diet alone , presence or absence of dysphagia, taste preferences, level of fatigue, availability of labour and resources for preparation, presence of safety and cost concerns. The suitability of enteral feeds over other feeding methods can be judged by checking the nutritional significance, safety for use, functional properties (flow, viscosity) and ease of processing (dispensability in water). Presently various enteral feeds are developed either at house hold level or instantly in the dietetic department of hospitals. The instant preparations of enteral feeds can be cumbersome and unsafe in terms of standard formulation and application on patient. Use of dry powders or enteral delivery sets can result in problems because of its microbial contamination. The field of specialized nutritional support needs to be evolved in our country. Most of the feeds available are either in extract form (restore formula for diabetes or protein, energy and micronutrient supplements) or household preparations which are proved to be unable to fulfill the nutritional requirements of the patient. This calls for the formulation of disease specific or standard enteral feeds based on natural food sources.

2 MATERIALS AND METHODS

2.1 Selection of the food ingredients

Seventeen ingredients from all the food groups were selected for developing the enteral formula feeds. The selection was based on the nutritional potential, adaptability to the processing, keeping quality and availability of the ingredient.

Table 1 Selected food ingredients to develop the feeds

Food group	Ingredients
Cereals & millets	Semolina , Rice flakes , Pearl millet
Legumes & Pulses	Whole green gram , Soybean
Fruits & vegetables	Carrot, Spinach, Banana, Aonla , lotus stem
Milk & milk products	Skim milk powder, Whey protein powder, Butter
Nuts & oil seeds	Gingelly seeds
Others Ers	Sugar, Oil, Salt

2.2 Nutritional Analysis of the Ingredients (Pre Processing stage)

All the selected ingredients were analyzed for their nutrient content at “pre” and “post” processing stages by using standard analytical procedures. At the pre processing stage all the maro nutrients i.e. crude protein, crude fat, crude fiber, carbohydrates and vitamin C content were estimated in the laboratory of Home science dept. international college for girls, Jaipur. Remaining micro nutrients i.e. vitamin A, folic acid, iron and sodium were measured by using outside sources. The methods followed for estimating the nutrients are listed below:-

Table 2 Standard analytical methods used under study

Nutrient	Analysis method (AOAC 1995)
Macro Nutrients • Crude protein • Crude fat • Crude fiber • Carbohydrate	 Micro Kjheldal method Sohxlet method Fiber tech (Acid base method) Computation method
Micro Nutrients • Vitamin A • Vitamin C • Folic Acid • Iron • Sodium	 Column chromatography & Spectrophotometer method Titration method HPLC method Spectrophotometer Spectrophotometer
pH	pH Meter

2.3 Processing of the ingredients & Post Processing Analysis

The food processing techniques applied to the selected ingredients were chosen, which could improve the food digestibility and acceptability without seriously affecting its nutritive value and diminishing the total food availability. All the ingredients were divided into two categories: dry ingredients (semolina, rice flakes, pearl millet, whole green gram,

soybean, gingelly seeds) and fresh ingredients (carrot, spinach, aonla, banana, lotus stem.). Other ingredients like skim milk powder, whey protein powder, sugar, butter, oil and salt needed no additional processing. The standard processing techniques applied of cleaning, soaking (Shrilakshmi 2005, joshi 2005), blanching (Potter, 1989) drying (Luis Ruthenburg 2011), germination (Modambi 2006, yashmin 2008), roasting (Shrilakshmi 2005)& popping (Murlikrishna 1986 , Rekha 1997), to dry and fresh ingredients are depicted in figure 1 and 2 respectively.

In post analysis the constituents like moisture and vitamin C , which could get affected due to heat application during processing were analyzed again for assessing their level of stability in the food ingredients. Along with this the germinated samples of pulses (whole green gram & soybean) were subjected to all the macro and micro estimations after processing.

2.4 Development of RTR Enteral Formula Feeds

On the basis of **RDA (recommended dietary allowances)** for adult male (Gopalan,1999) two basic RTR enteral feed were developed. All the processed food ingredients were mixed in the accurate amount and proportion to meet out the nutrient requirement of the patient. The standard formula (named **Nutriagent Std)** was planned to provide the RDA of a person which requires all the nutrients in the proportion given under normal physiological condition (as presented in the table 3). In the second formula (named **Nutriagent Protein Plus)** the ingredients were planed in such a way that provides protein content more then the standard formula. For developing both the feeds the RDA was modified according to the nutritional requirements of critical, bed ridden patients with long term need of enteral nutrition.

Table 3 RDA of reference an

Nutrients	RDA (ICMR)
Energy (Kcal/day)	2425
Protein (g/day)	60 (10%)
Fat (g/day)	20 (8-10%)
Carbohydrate (g/day)	485 (80%)
Fiber (g/day)	
β Carotene (µg/day)	2400
Ascorbic Acid (mg/day)	40
Iron (mg/day)	28
Calcium (mg/day)	400
Sodium (mg/day)	500
Folic Acid (µg/day)	100

Both of the developed enteral formula feeds were packed in self sealed low density polythene packets and wrapped properly in aluminum foil to minimize oxidation. The packets were stored in refrigerator to minimize deterioration and maximize shelf life. Cost of the enteral feeds was calculated, based on the cost of raw ingredients, and 20% cost of processing (fuel, electricity) packaging and storage (Sethi 2011). The calculated cost was compared with the market price of similar enteral formula feeds available in the time period of the present study.

2.5 Reconstitution Behaviour

The developed enteral feeds were reconstituted by mixing the known quantity of dry powder in different volumes of warm water with constant stirring and then cooling it to acceptable temperature. Reconstitution quality was be judged on the basis of flow behavior through standard ryle's tube of 10 pt. ,12 pt and 14 pt sizes. Reconstitution time and pH of the reconstituted sample were recorded.

2.6 Shelf life Evaluation of the formulated RTR Enteral formula feeds

The shelf life evaluation methodology of any developed food comprises of the physical examination, chemical (nutrients) testing and microbial analysis to ensure its edibility and over all food quality. The developed RTR enteral feeds were stored for a period of three months or 90 days. The shelf life quality of the developed feeds was checked on the basis of **sensory attributes** like color, flavor, taste, consistency/texture, and over all acceptability, **nutritional parameters** like moisture levels (Oven dry method (AOAC 1995)) & peroxide value (AOAC 1995) and **microbial parameters** like total viable count (Standard Plate count ISI 1991), total fungal count (APHA 1984) and coliform count (ENB Method APHA !984). These qualities were tested with an interval of each 30 days through out the period of storage.

2.7CLINICAL TRIAL

A small clinical trials of the developed RTR feeds was carried out on the patients admitted to the general ward of the PBM Hospital , Bikaner under the supervision of the medical staff of the ward. The permission of the Ethical committee comprised in the Sardar Patel Medical College, Bikaner was prior taken and then the sample of both the feeds were administrated orally to 4 patients respectively for 3 consequtive days. The patients were selected on the basis of their willingness to be the part of the study. The purpose of the trail was to check the acceptability and digestibility of the feed.

3 RESULTS & DISCUSSION

Ready to Reconstitute Enteral formula feeds Nutriagents Std and Nutriagent Protein Plus were formulated to suffice the RDA of a reference man. These feeds would provide complete nutrition for the patients with inability to swallow or any disability which could lead to malfunctioning of the buckle cavity. These Ready to Reconstitute Enteral formula feeds Nutriagents Std and Nutriagent Protein Plus were formulated to suffice the RDA of a reference man. These feeds were easy to reconstitute as well as to administer to the patient. The data on the **food composition** of the developed standard and protein rich feeds is presented in table 3. The major consideration while fabricating the feeds was incorporation of food ingredients from all the food groups in right proportion and amounts to reach the level of a balanced diet.

Table 4 Compositional details of developed RTR Enteral Formula feeds

Food Ingredient	Nutriagent Std		Nutriagent Protein Plus	
	Amount (g)	Compo. (%)	Amount (g)	Comp. (%)
Semolina	100	21.0	80	15.0
Rice flakes	85	17.0	60	11.0
Pearl millet	50	10.0	25	5.0
Whole green gram	45	9.0	60	11.0
Soybean	25	5.0	45	9.0
Gingelly seeds	40	8.0	25	4.0
Carrot	6	2.0	6	1.0
Spinach	6	2.0	2	1.0
Aonla	4	1.0	4	1.0
Banana	8	2.0	8	2.0
Skim milk Powder	35	7.0	60	11.0
Whey Protein Powder	0	0.0	54	10.0
Powdered sugar	50	8.0	60	11.0
Salt	1	0.2	1	0.2
Total feed Powder	**450**		**490**	
Butter *	25	5.0	25	5.0
Oil*	15	3.0	15	3.0
Total feed Amount	**490**		**530**	

- Butter and Oil would not be the part of packed feed powder but would be mixed at the time of reconstitution of the feed.

Jain and joshi (2005) has also carried a research work on the development of RTR formula feed. The data of that feed composition were presented to be as cereals and millet (35 %), pulses (14%), nuts & oil seeds 4 %milk powder 10%, vegetable slurry 28 %, sugar 7% and oil 2%. **Bilehal et al 2003** developed an antioxidant rich enteral food for oral and esophageal cancer patients. Ready to reconstitute mix was formulated based on barley, wheat, foxtail millet, green gram , soybean and skim milk powder tailored to provide the nutritional support to cancer patients. Further enriching B carotene with dehydrated carrot powder, , the mix was fortified with immune enhancing substrate arginine , RNA, n 3 fatty acids. Some protein rich feeds are suggested by dept of dietetics PGI Chandigarh. According to it a high protein diet comprised of 10% milk solids, 4% cereals, 10%sugar and 125 ml milk. In an another protein rich diet skim milk powder 150g was mixed in whey water along with sugar 50 g and coconut oil 20 gm. Various beneficial processing techniques like soaking, germination, roasting, popping, drying applied to the ingredients made the feeds easy to digest and provide maximum of the nutrition out of the nutritious food ingredients. The **Chilus (1989)** has reported that soaking increases the nutrient availability of the food. **Gopaldas and Deshpande (1988)** have reveled in his study that oven drying near the temperature range of 50^0C conserves the amylase activity in germinated grains. Further **Phillips 1990, Joshi 2005, Khali et al 2006** reported that germination of seeds enhances the nutrient content of the pulses as well as minimizes the enzymatic activity inside the food components. According to **Bau and others (2000),** soybean germination leads to substantial increase in certain biochemical and biologically active compounds of the beans. **Bhupender Singh (2007)** favored the popping of pearl millet as it increases the starch susceptibility. The ultimate nutritional composition of both the developed formula feed is depicted in table 4 and 5. The nutritional value of the feeds is compared with the RDA, which they are intended to meet. The comparison data proves the sufficiency of the formulated feeds to provide the whole some nutrition in terms of maro and micro nutrients.

Table 5 Nutritional composition of the developed Standard RTR enteral formula feed Nutriagent Std

Nutrient	Guidelines for Nutritional composition	Nutriagent Standard
Energy (kcal)	**2000**	**2010**
Crude Protein (g)	**75**	**75**
Crude fat (g)	**65**	**65**
Crude fiber (g)	**8.5**	**12**
Carbohydrates (g)	**275**	**278**
β carotene (ug)	**1500 -12,000**	**2130**
Vitamin C (mg)	**56-317**	**98**
Folic Acid (ug)	**200-1080**	**204**
Iron (mg)	**4.5-24**	**31**
Sodium (mg)	**350-1184**	**432**

♦Modifications in the RDA is on the basis of the literatures provided by Moshe Shike (1999) and DAA (2011)

Table 6 Nutritional composition of the developed Protein Rich RTR enteral formula feed Nutriagent Protein plus

Nutrient	Guidelines for Nutritional composition	Nutriagent Protein plus
Energy (kcal)	**2000**	**2004**
Crude Protein (g)	**100**	**101**
Crude fat (g)	**65**	**67**
Crude fiber (g)	**8.5**	**13**
Carbohydrates (g)	**250**	**257**
Vitamin A (ug) (B Carotene)	**1500-12,000**	**2155**
Vitamin C (mg)	**56-317**	**101**
Folic Acid (ug)	**200-1080**	**215**
Iron (mg)	**4.5-24**	**28**
Sodium (mg)	**350-1184**	**434**

♦Modifications in the RDA is on the basis of the literatures provided by Moshe Shike (1999) and DAA (2011) and ESPN Guidelines on Enteral Nutrition 2006.

The comparative view of both the developed feed showed equal nutrient sufficiency. The difference in protein and carbohydrate was justifiable as the Nutriagent Protein Plus was intended to provide more amount of protein than NutriagentStd. They generally have caloric density of 1 kcal/1 mL and are isotonic, but may be concentrated to 1.5- 2 kcal/1 mL. In a standard formulation, 15 to 25 % of the calories are

protein, the sources being cow milk (casein, casemate and whey protein), eggs (egg white), soy (soy protein) and wheat (wheat protein, gluten and gliadin). The sources of fat include corn oil, sunflower oil, soybean, butter fat or beef fat. Diets which are enriched with medium chain triglycerides (MCTs) are isolated from coconut oil. In these formulas the main source of carbohydrates is maltodextrin. The content of electrolytes and micronutrients (vitamins and trace elements) is within the range of recommended daily allowances (RDA). **Hale AKBAYLAR 2002** According to DAA 2011 and Verma 2006 Most of the standard enteral formula feed provides 1 kcal of energy per ml of the feed. The protein content of the standard feed could range from 4-32 % and on an average 50 % of the total energy content of the feed. Where as the carbohydrate and fat content can contribute as 50-60 % and 30-55 % of the total calorie density respectively **(Lord 1996, Shike et al 1994, Joshi and Jain 2005). Berner 1989 , Shike 2009 and Olree 1998** claims that various enteral feeding solutions which are designed to provide the energy content of 1500- 2000kcal are intended to suffice the (RDI) Recommended Dietary Intake of vitamins and minerals also. Patients maintained on enteral feeding for period exceeding 6 months had normal and high blood levels of th various vitamins and minerals. The developed feeds were packed in self sealed low density polythene packets and wrapped properly in aluminum foil. They were stored properly under the refrigeration for better keeping quality and reduced self deterioration. The cost of the enteral feeds was calculated and is illustrated in table 6.

Table 7 Cost comparison of the developed enteral formula feeds with the commercially available enteral formula feeds.

Product	Quantity	Cost
Nutriagent Std	490g	34 (Rs)
Nutriagent Protein Plus	530g	120 (Rs)
Jevity1.5	8 oz (227g)	2436 (Rs)
Jevity1.2 High protein	8 oz (227g)	541 (Rs)
Iso source	8 oz (227g)	133 (Rs)
Ensure	8 oz (227g)	635.6 (Rs)
Nestle Glytrol	8.4 oz (238g)	1895 (Rs)

The cost comparison of the developed RTR enteral formula feeds with other commercially available formula proves the cost effectiveness of the developed feeds. They deliver wholesome nutrition with economic price. The reconstitution behavioral attributes of the developed enteral formula feeds is presented in table 6. The packed amount of feed powder (450g and 490 g) were mixed in the calculated amount of water required (77% and 75%) for the reconstitution and the reconstitution time was also checked. The liquid feeds were passed through three sizes of Ryle's tube i.e. 10 , 12 and 14 pt. and the flow rates were recorded. The guidelines given in the manuals of **DAA 2011** and **ASEN journal of enteral and Perenteral nutrition 2006** have clearly stated that the enteral feeding solution with calorie density of 1- 2 kcal/ml should contain 70-85% of water. Similarly **Verma 2006, Joshi 2005 and Sharma 2009** have also suggested the water content of tube feeding solutions as 70-90% depending upon the energy content of the formula feed.

Table 8 Reconstitution behaviour of the developed RTR Enteral Formula feeds

Enteral feed	Ratio of Feed: water added	Recon. time	pH	Total volume of feed
Nutriagent Std	1:3 (75% water with 25 % enteral feed mix)	7.0 ±1.0	5.9±0.5	2000ml / 2L
Nutriagent Protein Plus	1:3 (75% water with 25 % enteral feed mix)	8.0 ±1.0	5.5±1.0	2000 ml/ 2L

Gastric motility is reportedly slowed with solution lower than pH 3.5.The pH level of most commercial formulas is > 3.5. (www.indiandoctors.com)The pH of the developed feeds under the study could consider safe to maintain the gastric motility of the patients. The **shelf life qualities** of the developed feeds were found favorable on all the parameters: sensory, nutritional and microbial. The sensory evaluation conducted to check the organoleptic qualities of the feeds concluded the good over all acceptability of them. The nutritional and microbial profiles of shelf life is presented in table 7 and 8 .The moisture levels , peroxide value and the microbial load of the feeds were also depicted to be with in the permissible limits considered safe for the consumption.

Table 9 Nutritional parameters of the developed RTR enteral feeds during storage foe 90 days

Stages of storage	Moisture levels		Peroxide value	
	Nutriagent Std	Nutriagent Protein Plus	Nutriagent Std	Nutriagent Protein Plus
0^{th} day	6.0 (±0.6)	6.3 (±0.9)	0.0 (±0.0)	0.0 (±0.0)
30^{th} day	6.7 (±0.6)	7.0 (±0.9)	2.0 (±1.0)	3.7 (±0.6)
60^{th} day	7.2 (±0.9)	6.9 (±0.6)	3.5 (±0.6)	3.7 (±1.2)
90^{th} day	7.5 (±0.8)	8.0 (±1.0)	3.5 (±0.5)	4.3 (±0.6)

Additionally the product were properly dehydrated and mixed and stored under conditions which kept the moisture level low enough, the chemical reactions which can occur during storage and result in nutrient deterioration during storage/ distribution were minimized to a greater extent.

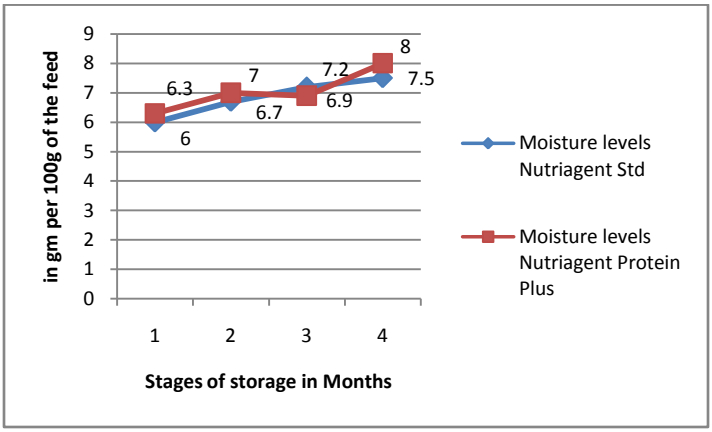

Figure 1 Comparison of the moisture levels present in the developed feed during the storage of 90 days

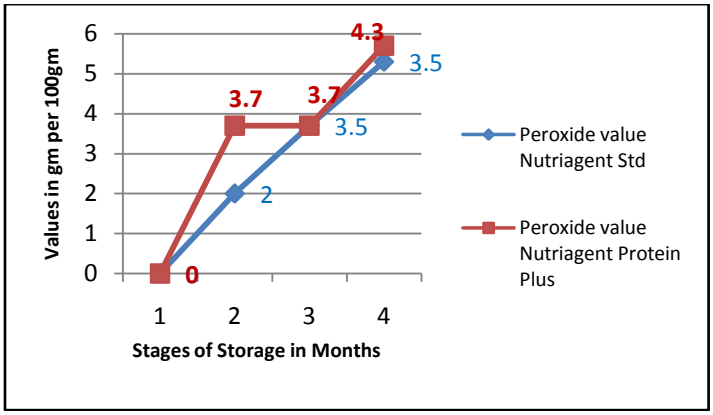

Figure 2 Comparison of the peroxide values in the developed feed during the storage of 90 days

During storage the food product which shows the peroxide value i.e. >10 is considered as safe and fit for consumption (Aylward 1999). The peroxide values estimated in both the developed enteral formula feeds were proved to be with in the safe limit consecutively at every stage of storage.

Table 8 Microbial parameters (Total Viable Count) of the developed RTR enteral feeds during storage for 90 days

Microbial count	Total Viable count	
	Nutriagent Std	Nutriagent Protein Plus
0th Day	3.53x103±0.11	4.93 x103 ±0.2
30th Day	3.03 x103±0.31	4.40 x103±0.45
60th Day	2.06 x103±0.21	3.96 x103±0.82
90th Day	2.00 x103±0.10	3.60 x103±0.27

According to Pelczar et al 2003 the microbial load of the drinking water in terms of bacteria should not exceed the permissible limit i.e. 1000-10,000 per liter of the water. This can also be applicable for the food products. The total viable count of the developed feeds were found to be within the specified safe limit. The other microbial tests like coliform count and fungal count showed negligible presence of the respectable microbes. Clinical trial of samples of the developed RTR enteral formula feeds supported the good acceptability and digestibility of the feed. All the subjected (8, four for each sample) who were fed with the **Nutriagent std and Nutriagent protein plus** showed no complications (like nausea, vomiting, regurgitation, gas production, cramp, head ache or stomach ache) in reference with its swallowing, and digestion of the feeds.

4 CONCLUSION

The results of this study demonstrate that despite the commercially available enteral formula feeds, the RTR enteral feeds developed under the present study render complete and predictable levels of micro-nutrients and macronutrients. These feedings were more likely to be easy to reconstitute and safe, which may result in clinical and nutritional implications for patients at risk of malnutrition due to difficulty in oral feedings.

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Figure 3 Processing of Non perishable food samples

Semolina	Rice flakes	Pearl millet	Whole green gram	Soybean	Gingelly seeds
Cleaning ↓ Sorting ↓ Roasting ↓ Cooling (room temp.) ↓ Soaking (in warm water) ↓ Oven drying ↓ Grinding ↓ Sieving	Cleaning ↓ Roasting ↓ Cooling (room temp.) ↓ Grinding ↓ Sieving	Cleaning ↓ Blanching ↓ Oven drying ↓ Popping ↓ Cooling (room temp.) ↓ Grinding ↓ Sieving	Cleaning ↓ Washing (tap water) ↓ Soaking (12 hours) ↓ Germination (24 hours) ↓ Oven drying ↓ Grinding ↓ Sieving	Cleaning ↓ Washing (tap water) ↓ Soaking (12 hours) ↓ Germination (48 hours) ↓ Oven drying ↓ Grinding ↓ Sieving	Cleaning ↓ Sorting ↓ Roasting ↓ Cooling room temp.) ↓ Grinding ↓ Sieving

Figure 4 Processing of Perishable food samples

Carrot	Spinach	Aonla	Banana	Lotus stem
Cleaning ↓ Sorting ↓ Washing (under tap water) ↓ Peeling ↓ Blanching ↓ Shredding ↓ Oven drying ↓ Grinding ↓ Sieving	Cleaning ↓ Sorting ↓ Washing (under tap water) ↓ Blanching ↓ Slurry formation ↓ Oven drying Grinding ↓ Sieving	Cleaning ↓ Sorting ↓ Washing (tap water) ↓ Slicing & Deseeding ↓ Shredding ↓ Oven drying ↓ Grinding ↓ Sieving	Cleaning ↓ Sorting ↓ Peeling ↓ Slicing ↓ Oven drying ↓ Grinding ↓ Sieving	Cleaning ↓ Sorting ↓ Washing tap water) ↓ Peeling ↓ Blanching ↓ Shredding ↓ Oven drying ↓ Grinding ↓ Sieving