Review Article
ISSN (Online): 2454-1907

International Journal of Engineering Technologies and Management Research
July 2024 11(7), 49–59

SCIENTIFIC AND TECHNICAL REVIEW OF NATURAL CAMEROONIAN BASED FOODS AND DEVICES FOR ADMINISTRATION BY ENTERAL TUBE FEEDING

Cybèle Taga Maka [1], Yvette Jiokap Nono [2], Hilaire de Goethe Mbiatat [3]

[1] Department of Process Engineering, National School of Agro-Industrial Sciences (ENSAI), University of Ngaoundere, Ngaoundere, Cameroon
[2] Department of Chemical and Environmental Engineering, University Institute of Technology (IUT), University of Ngaoundere, Ngaoundere, Cameroon
[3] Dietetic Department, General Hospital of Douala, Douala, Cameroon

Received 05 June 2024
Accepted 08 July 2024
Published 25 July 2024

Corresponding Author

Cybèle Taga Maka,
makacybele@yahoo.fr

DOI
10.29121/ijetmr.v11.i7.2024.1478

Funding: This work was supported by the Institut de la Francophonie pour le development durable (IFDD/Canada)/ Projet de Déploiement des Technologies et Innovations Environnementales (PDTIE) funded by the Organisation internationale de la Francophonie (OIF), the Organisation of African, Caribbean and Pacific States and the European Union (EU) (FED/220/421-370).

ABSTRACT

Enteral feeding is a medical indication for people who cannot, should not, or no longer want to feed themselves through their mouth, and thus use a tube for that. In some countries, local foods were used because of the high cost and low availability of imported pharmaceutical products. Unfortunately, the blenderized food used have uncontrolled nutritional composition, and are not fluid enough. It leads to the feeding tube clogging. Pharmaceuticals and enteral feeding devices can help the food to flow easily by gravity, and many of them are patented. Some food technologies for making fluid products are known and their operating conditions generally have to be found regarding the type of equipment and raw materials composition. Therefore, with an appropriate process, it is possible to obtain a food from local sources, flowing through an enteral tube feeding only by gravity assistance without clogging. This situation encourages innovations based on local foods, fluidification techniques defined for a process and delivery devices, for the formulation of an enteral food. But some administrative constraints regarding the implementation strategy onsite, are likely to hinder the availability of local enteral feeding products, needing the creation of new requirements. The aim of this review is to present the current problems by bringing out the scientific, technical and administrative knowledges of the existing situation, in Cameroon especially, in order to propose innovative solutions.

Keywords: Food, Enteral Tube Feeding, Process, Innovation

How to cite this article (APA): Maka, C. T., Nono, Y. J., and Mbiatat, H. G. (2024). Scientific and Technical Review of Natural Cameroonian Based Foods and Devices for Administration by Enteral Tube Feeding. *International Journal of Engineering Technologies and Management Research, 11*(7), 49–59. doi: 10.29121/ijetmr.v11.i7.2024.1478

1. INTRODUCTION

Some patients are medically forbidden to eat orally, they must use a tube: this is artificial enteral feeding that can be done in hospital and at home Smith & Garcia (2011). Commercial pharmaceuticals, although they flow without too much difficulty through the tubes, they contain many chemical additives for their preservation and stabilization, which are relatively tolerated by the body. In addition, in country like Cameroon, they are not always accessible to a large majority of patients, especially for those who have to use them in the medium and long terms because they are expensive and not available. These are the reasons why natural foods are encouraged in enteral nutrition Bobo (2016), Drago & Galan (2014), Kaur (2009), Walia et al. (2016). The development of enteral formulas of good nutritional quality from local natural sources is an idea to be implemented at home to limit the length of hospitalization and reduce overall hospital costs Ojo (2015) These products are healthy and appreciated by those affected Fessler (2015), Phillips (2021), Susetyowati et al. (2019), Susetyowati et al. (2022). In some parts of the world, for economic and cultural reasons, medical staff use blenderized foods for enteral nutrition in some hospitals (Abbott Laboratories, 2014). In Cameroon, the need for enteral nutrition is generally felt in all hospital medical departments (general medicine, surgery, intensive care, oncology, paediatrics, ...), and at home for those who need to continue long-term treatment. Ready-to-use imported nutrient solutions are used, alternating with gruels made from local foods because of their lower cost, allowing a save of nearly 80% of the price of imported products. Unfortunately, the gruels used, like the majority of homemade products or products based on whole natural ingredients, lead to clog the tubes, due to their consistency, the presence of lumps and a certain instability Bobo (2016). To this end, they are administered by bolus, requiring the use of a syringe to force the flow, which is manual, generates harmful side effects in the patient because the feeding rate is not regular, and requires the permanent assistance of medical staff resulting in a loss of time Smith & Garcia (2011). It would be very useful to intervene because they are unsuitable in comparison to the gravity flow, the preferred administration mode, which is less restrictive than the bolus mode and less expensive than the pump administration. In addition, the nutritional composition of homemade products is not controlled, requires a significant amount of handling time for preparation with additional unit operations and presents a high risk of microbiological contamination Fessler (2015), Mihály et al. (2001), Vieira et al. (2018). The main problem lies in the contradiction of the engineering parameters, namely the increase in the material quantity to improve the nutritional value, which would tend to deteriorate the flow rate. And vice versa, by improving the product flow rate by dilution to reduce viscosity, which would tend to lower the nutritional value consumed. Dilution increases the volume of the food, which would be greater than the stomach capacity. The possible solutions to find a compromise between rheological properties and nutritional parameters result in the choice of raw materials with technological aptitude in relation to specific unit operations, which under appropriate conditions, will generate a fluidification and stabilization effects on the product without changing the material quantity or the nutritional value. Other solutions would also be to play with the tube by modifying its delivery mechanism or maintenance. This review will therefore consist of exploring the scientific aspects to better identify the elements of solutions, the technical aspects to present the concrete achievements around the enteral foods production and the administrative aspects to make an inventory of the legal-commercial component commenting on the rules related to these products.

2. SCIENTIFIC REVIEW

2.1. LOCAL RAW MATERIALS USED FOR ENTERAL NUTRITION

The food intended for enteral nutrition must be fluid in order to easily flow through the enteral tube feeding, however it must be nutritious. Generally, four main groups of constituents are needed to cover energy and nutritional requirements Schneider (2006): carbohydrates, fats, proteins, vitamins and mineral salts. Given the wide variety of food resources abounding in Africa, and Cameroon in particular, enteral formulas of good nutritional quality based on natural foods can be developed. The carbohydrate sources used in the preparation of gruels generally consists of cereals Belton & Taylor (2004), Ratnavathi & Chavan (2016), Tizazu et al. (2010). Those available in Cameroon are sorghum and millet in the Adamawa, Far-North, North and North-West regions; maize is available in all regions but much more in the West, North, Center, Adamawa, South-West, Far-North and Littoral MINADER (2012). Sometimes, some tubers such as cassava Osungbaro et al. (2010) and sweet potato Obiakor-Okeke et al. (2014), Sanoussi et al. (2013), mainly produced in the Center MINADER (2012), are used. Their production is respectively 4,858,329 tons and 1,815,246 tons FAOSTAT. (2022). Proteins generally come from powdered milk imported in Cameroon, but also from cowpeas, soybeans and dried beans Sanoussi et al. (2013), Shiriki et al. (2015), with a production of respectively 166,145 tons MINADER (2012), 24,195 tons, and 422,171 tons FAOSTAT. (2022) in all regions, mainly in the Far North, West and North-West MINADER (2012). Smoked fish and shrimp are also used as protein sources. As far as lipid coverage is concerned, it is provided by oilseeds such as peanuts Bassey et al. (2013), Kouebou et al. (2006), Mahmoud et al. (2014), Shiriki et al. (2015) Shiriki et al. (2015) Shiriki et al. (2015) Shiriki et al. (2015), squash and seeds, sesames Onabanjo et al. (2009) with production of respectively 500,000; 185,901; and 68,422 tons FAOSTAT. (2022) in all regions mainly in the North, Far North, East, Centre, South and Littoral MINADER (2012). Vegetable oil Mahmoud et al. (2014) is sometimes introduced as a lipid source. Finally, the mineral and vitamin component can be covered by most common fruits Bassey et al. (2013), Honfo et al. (2011) or by adding mineral and vitamin supplements Kaur (2009). It should be noted, however, that the physicochemical properties of the food will depend on the point of fall in the digestive tract corresponding to the position of the tube. From the stomach to the pylorus, the path becomes increasingly short. As a result, the food must be less and less complex, therefore must have more and more simple compounds that are easily assimilated and absorbed by the body through the tissues lining the digestive tract for a sufficient supply of nutrients.

2.2. UNIT OPERATIONS OF FLUIDIFICATION FOR THE NUTRIENT MIXTURES

Fluidify gruels or nutrient mixtures made from several foods need several treatments to be are applied. Dilution is an option except that, depending on the initial consistency, the volume to be consumed for the same amount of matter could be greater than the gastric capacity Mouquet et al. (1998). Acid hydrolysis consists of preferentially solubilizing the amorphous zones of starch grains by attacking the α (1-4) terminal hemiacetal bonds. Extrusion cooking is a drastic hydro-thermal treatment that damages the starch and causes the structural chains to break, resulting in an instant product Trèche & Mouquet-Rivier (2008). The addition of enzymes, particularly α-amylases, would hydrolyse the starch, thus causing a rapid decrease in viscosity Kampstra et al. (2018). These techniques are still much more used by manufacturers because they are still very expensive Trèche & Mouquet-Rivier (2008). Fermentation is one of the ways to fluidify gruels, but it doesn't do it as much as sprouting Wambugu et al. (2003). The latter is the most appropriate technique because it is less expensive and effective, which could make it possible to design an enteral nutrition food based on local resources that will flow through the tube Kaur (2009). Indeed, the increase in amylase and protease activities during germination would reduce viscosity Dziedzoave et al. (2010), Elkhalifa & Bernhardt (2010), Hassani et al. (2014). The enzymatic activities acquired during malting can be further exploited by incubating the flour suspension under conditions of optimal activities of synthesized enzymes Elkhalifa & Bernhardt (2010), Ick et al. (2007), Méndez-albores et al. (2009).

Some authors have presented roasting Kaur (2009), Maka & Jiokap Nono (2022), Ranganathan et al. (2013), grinding Cappelli et al. (2020), Kaur (2009), cooking Ozola & Kampuse (2017) and spray drying Kaur (2009) operations as being able to be used for the production of enteral foods. Freeze-drying can also be used to produce instant enteral foods Fei & Xiaoha (2012) to ensure the long term stability of the product, and its direct consumability. As gruel are prepared by mixing the food, in powder, with water. Unfortunately, the water quality is not always good and hygienic at the household scale Trèche & Mouquet-Rivier (2008).

All these fluidification processes can be combined for a combination of effects, but as much as there is a combination of fluidification advantages, there is also a combination of costs. It should be noted here that the use of these operations must be done to make the foods fluid without changing their energy consistency.

3. TECHNICAL REVIEW

This part discusses the processes used, the products obtained and the equipment or devices developed for enteral nutrition.

3.1. ENTERAL NUTRITION: PROCESSES AND PRODUCTS

The pharmaceutical products marketed are many and varied, and generally do not present the flow problems in the tube. They can be specific to a pathology or for general uses.

Few works have been done on enteral nutrition products from commonly consumed foods, whole foods, or partially processed products. Vacuum cooking Ozola & Kampuse (2017) and high-pressure cooking Ozola et al. (2017) have been explored in order to see the impact of their conditions on the bioactive compounds of a juice as enteral food from blackcurrant, beetroot, pumpkin, cabbage and Jerusalem artichoke, and whey proteins, rapeseed oil, cod liver oil, iodized salt as ingredients. Kaur (2009) studied the influence of some unit operations conditions on the nutritional and rheological parameters, namely the germination and grinding of millet and beans, the roasting of soybeans, and the bursting and grinding of amaranth seeds for the formulation of an enteral feed containing in addition to milk, yoghurt, oil, chicken eggs, gum arabic with mineral and vitamin supplements. His work has shown that malting is a very important operation insofar as we would like to have enteral formulas based on natural sources that will be fluid enough to flow through the enteral tube feeding. Other formulations were made from tempeh and jicama flours, with soybean oil, skim milk, maltodextrin, and sugar Sutikno et al. (2020). Other research has investigated the influence of incorporating foods such as rice, chocolate, tea, and banana smoothie on the bioavailability of minerals when mixed with commercial enteral foods Drago & Galan (2014).

Commercial and patented products are generally made up of isolated, extracted, or nearly refined compounds as ingredients. Some of them are intended for specific clinical cases such as patients with chronic obstructive pulmonary disease developed by Ruijie et al. (2022). Another example is an enteral nutrition product adjusting dysbacteriosis of the intestinal tract which was obtained by freeze-drying of some compounds by Min (2017). Chen et al. (2011) have developed an enteral nutrition formula, stable and liquid, and its preparation process for general medical purposes. Some emulsifying agents are formulated for enteral feeding products Anhui Huaming Pharmaceutical CO. LTD. (2017). These stabilizers and emulsifiers are usually synthetic chemicals or chemically modified extracted compounds.

3.2. EQUIPMENT AND DEVICES DEVELOPED FOR ENTERAL NUTRITION PRODUCTS

The improvement of flow in the enteral tube feeding can be played on the food or on the tube device. The patented enteral foods do not address or very little flow problems at all, because most ingredients have more simple molecules from isolated or extracted compounds than long-chain polymeric molecules. However, several enteral feeding devices are also being developed to help solve this problem, such as high rate connection systems Russo (2022), nasal feeding tubes for enteral nutrition with multifunctional constant temperature and automatic flush Weihong et al. (2022), home enteral nutrition management devices Jiayiing et al. (2022) and anti-clog function tubes Ru (2021).

Be-cooked flours, instant flours, and gruels are forms of products that can be used for enteral nutrition. Their production equipment exists on the market at several sales sites in various quantities and characteristics, namely sorters, steeping tanks, sprouters or ovens, roasters, dryers (convective air, spray or freeze-drying), degermers, shellers, mixers, grinders, sieves, incubators, cookers (water, steam, and vacuum). However, the yield production would be different depending on the raw materials processed since they have different characteristics. There is therefore a lot of innovations on the design of equipments, unit operations and processes applied to a specific food according to local materials.

Works have been done in the development of gruels and enteral foods Drago & Galan (2014), Kaur (2009), Ozola et al. (2017), Ozola & Kampuse (2017), Sutikno et al. (2020). But very few of them look at gruels, prepared from local foods, as food for enteral feeding with the aim of flowing by gravity through the tube feedings. However, fluidification processes could be optimized for this purpose.

4. LEGAL AND COMMERCIAL ASPECTS

The target population of enteral feeding products consists of people who, depending on the clinical case, cannot, do not want to or do not have to eat orally under medical indication. Hospitals that use liquid foods made from local foods for enteral nutrition are open to improvements related to the flow of these products through the tubes without deterioration in energy value, because this is the main challenge for these foods. However, these products are subject to standards related to devices and products.

4.1. STANDARD DEVICES

At the international level, there are several standards such as the ISO 20695:2020 standard, related to the use of enteral nutrition systems (devices) so that they do not compromise clinical conditions and patient safety. As well as the ISO 80369-3, 18250-3 and 80369-1:2018 standards, which define the usable connections between enteral tubing, enteral nutrition extenders, enteral syringes, enteral feeding tubes and accessories, enteral nutrition containers, as well as their use. In Cameroon, there are no special requirements. However, some instructions must be followed depending on the authorities: the hospital's ethics committee, the Cameroon Medical Association or the Cameroon Order of Medical Doctors, or the Health Ministry. These instructions are completed with concepts learned in medical schools or through onsite experience in accordance with the emergency of life context.

4.2. STANDARD PRODUCTS

International standards for devices are product-related. In relation to the characteristics of the food, it is specific according to pathologies and ages. However, these characteristics are not listed in a specific standard because some foods are adaptable and adjustable depending on the case. This is why it is preferable to design a food in relation to the daily energy needs, then to readapt according to restrictions, pathologies or preferential constituents according to the clinical cases.

There are no Cameroonian standards specific to enteral products. On the other hand, the Cameroonian food standards (CN) related to the same type of product are: the CN 43 Standard: 2014 – ICS Code 01.120 related to microbiological criteria relating to food - inspired by the international reference CAG/GL 21 – 1997; CN Standard 54: 2014 – ICS Code 67.180.10 for Vitamin and Mineral Supplements – based on the ISO 12824-2016 International Reference. A current standard for infant formula and infant formula addressed for special medical purposes – based on International Reference CXS 72 – 1981 revised in 2006 and amended in 2017 and 2019. There are no specific standards for foods for enteral nutrition that must be administered through tubes. In Cameroon, enteral nutrition from local sources is not regulated by the high health authorities and not supported by the public authorities. Decisions are therefore intrinsic to each hospital. This is why some hospitals are reluctants about the use of commercial local products in the form of gruels for enteral feeding. They are not convinced of the nutritional and microbiological quality of these gruels because the imported enteral products, being ready-to-use requiring little or no contact with tools and humans. Unlike local enteral foods, although naturals, also require cooking related to the time-temperature parameters, as well as water with not assured quality. For few rare hospitals that have adopted these foods, a product must be validated at the level of the board of directors of the institution in question to be used permanently. Sometimes the approval of the hospital dietician can be enough to convince the use of a food for medical purposes. Guidelines in this case are specific to each hospital. These guidelines can be proposed in other hospitals by sharing their experience with enteral foods made from local foods, and then passed on to the country's health authorities, who seeing their usefulness and necessity, could contribute to the development of a standard or integrate it into a standard close to the same type of food.

4.3. ETHICS CLEARANCE

Like any product, food to be marketed are subject to several rules, namely standards. For products intended for medical purposes, they must also receive the Administrative Authorization of Research (AAR) from the Ministry of Health through the clearance of ethics, if clinical trials are to be carried out, according to law No. 2022/008 of April 27, 2022, on medical research involving the human person in Cameroon. Ethics clearance is an approach to resolve conflicts of values, supposed or proven, between biotechnological advances and fundamental rights to protect human dignity. It is an opinion given by the ethics body, after its approval of the scientific value and compliance, with ethical principles of the research protocol submitted by the sponsor or investigator. International and Cameroonian regulations for human health research require the protection and safety of participants during the planning and implementation of research projects. These include: protection against the risks of exposure to research-related interventions and interactions; rights and dignity of research participants. The procedure can last for a month after the application has been submitted, but may take longer depending on the context.

5. CONCLUSIONS

To make nutrient mixtures fluid without changing the amount of material, several unit operations can be operated under conditions as different as each other and depending on the specificities of the raw materials. Several innovations in equipment and devices aimed at producing food and facilitating its flow through a tube with regard to products intended for enteral feeding, are available. On the other hand, very few products formulated with local foods have ensured this ease of use, focusing only on the nutritional and clinical aspects. Enteral product standards are particularly concerned with administration procedures and not with the food itself. A food enteral product may, however, be marketed like any other food product without specification of its medical purposes. In this case, only agri-food standards are required. The enteral products developed can be in two forms, liquid and instant powder for better preservation, this to have the advantage of being "ready-to-use", easy to use, available and less expensive because they are made from local and natural foods with the possibility of flowing by gravity.

CONFLICT OF INTERESTS

None.

ACKNOWLEDGMENTS

None.

REFERENCES

Anhui Huaming Pharmaceutical CO. LTD. (2017). Enteral Nutritionemulsion Containing Lipoic Acid (p. Patent N° CN106418485).

Bassey, F. I., Mcwatters, K. H., Edem, C. A., & Iwegbue, C. M. A. (2013). Formulation and Nutritional Evaluation of Weaning Food Processed from Cooking Banana, Supplemented With Cowpea and Peanut. Baker 1994, 1-8. https://doi.org/10.1002/fsn3.51

Belton, P. S., & Taylor, J. R. (2004). Sorghum and Millets: Protein Sources for Africa. Trends in Food Science & Technology, 15(2), 94-98. https://doi.org/10.1016/j.tifs.2003.09.002

Bobo, E. (2016). Reemergence of Blenderized Tube Feedings: Exploring the Evidence. https://doi.org/10.1177/0884533616669703

Cappelli, A., Oliva, N., & Cini, E. (2020). Stone Milling Versus Roller Milling: A Systematic Review of the Effects on Wheat Flour Quality, Dough Rheology, and Bread Characteristics. Trends in Food Science and Technology, 97, 147-155. https://doi.org/10.1016/j.tifs.2020.01.008

Chen, Z., Han, L., He, M., Liu, L., Sun, F., Wang, X., Zhang, Y., & Zhou, H. (2011). A Stable Medical Liquid Enteral Nutrition Composition and its Preparation Method (p. Patent N° AU2021101134).

Drago, S. R., & Galan, M. G. (2014). Food Matrix and Cooking Process Affect Mineral Bioaccessibility of Enteral Nutrition Formulas. Journal of the Science of Food and Agriculture, 94(March), 515-521. https://doi.org/10.1002/jsfa.6280

Dziedzoave, N. T., Graffham, A. J., Westby, A., & Komlaga, G. (2010). Comparative Assessment of Amylolytic and Cellulolytic Enzyme Activity of Malts Prepared from Tropical Cereals. Food Control, 21(10), 1349-1353. https://doi.org/10.1016/j.foodcont.2010.04.008

Elkhalifa, A. E. O., & Bernhardt, R. (2010). Influence of Grain Germination on Functional Properties of Sorghum Flour. Food Chemistry, 121(2), 387-392. https://doi.org/10.1016/j.foodchem.2009.12.041

FAOSTAT. (2022). (Statistique de la FAO) [WWW Document], 2020. (consulté le 29/11/2022).

Fei, S., & Xiaohai, S. (2012). Freeze-Dried Flour and Preparation Method There of - Google Patents (p. Patent N° CN102696717A).

Fessler, T. A. (2015). Blenderized Foods for Home Tube Feeding: Learn About the Benefits, Risks, and Strategies for Success. Today's Dietitian, 17(1), 30.

Hassani, A., Zarnkow, M., Becker, T., Hassani, A., Zarnkow, M., & Becker, T. (2014). Food Science and Technology International Fermented Beverages for Fermented Beverages. https://doi.org/10.1177/1082013213490710

Honfo, F. G., Tenkouano, A., & Coulibaly, O. (2011). Banana and Plantain-Based Foods Consumption by Children and Mothers in Cameroon and Southern Nigeria: A Comparative Study, 287-291.

Ick, S., Joo, C., Kim, D., Ah, H., Cheong, J., Min, K., Baik, M., Seok, C., Ho, C., & Wha, T. (2007). Formation, Characterization, and Glucose Response in Mice to Rice Starch with Low Digestibility Produced by Citric Acid Treatment, 45, 24-33. https://doi.org/10.1016/j.jcs.2006.05.001

Ikujenlola, V. A. (1996). Chemical and Functional Properties of Complementary Food Blends from Malted and Unmalted Acha (Digitaria Exilis), Soybean (Glycine Max) and Defatted Sesame (Sesamun Indicum L.) Flours. African Journal of Food Science, 8(7), 361-367. https://doi.org/10.5897/A

Jiayiing, T., Xiaoxia, H., & Yao, L. (2022). Household Enteral Nutrition Management Device (p. Patent N° CN215604808).

Kampstra, N., Nguyen, V., Koenders, D., Schoop, R., Broersen, B., Mouquet-Rivier, C., T, T., MJ, B., & de Pee, S. (2018). Energy and Nutrient Intake Increased by 47-67% When Amylase was Added to Fortified Blended Foods-A Study Among 12-35 Months Old Burkinabe Children. Matern Child Nutr, 14(1). https://doi.org/10.1111/mcn.12459

Kaur, M. (2009). Medical Foods from Natural Sources. https://doi.org/10.1007/978-0-387-79378-8

Kouebou, C. P., Essia Ngang, J., Dzudie, T., Mbofund, C. M., & Etoa, F. (2006). Antimicrobial Activities of Kilbu and Tamarind Pulp Extracts Used in Traditional Medicine and Cereal Gruel in Cameroon. International Journal of Tropical Medecine, 1(4), 145-151.

Mahmoud, A. H., Mohammed, A., & Anany, E. (2014). Nutritional and Sensory Evaluation of a Complementary Food Formulated from Rice, Faba Beans, Sweet Potato Flour, and Peanut Oil. 35(4), 403-413. https://doi.org/10.1177/156482651403500402

Maka, C., & Jiokap Nono, Y. (2022). Rheological Characterisation of Gruels Made from Some Bio-Based Ingredients Commonly Used in Food Products. International Journal of Food Engineering, 18. https://doi.org/10.1515/ijfe-2021-0209

Mihály, I., Telegdy, L., Ibrányi, E., Lukács, A., Rókusz, L., Bánkuti, É., & Dóczy, J. (2001). Bacterial Contamination of Blenderized Whole Food and Commercial Enteral Tube Feedings in the Philippines. In Journal of Hospital Infection, 49(4), 268-273. https://doi.org/10.1053/jhin.2001.1093

Min, F. (2017). A Composite Enteral Nutrition Product Adjusting Intestinal Tract Dysbacteriosis and a Preparing Method Thereof (p. Patent NCN106880035).

MINADER (Ministère de l'Agriculture et du Développement Rural), (2012). Direction des enquêtes et des statistiques agricoles, Agristat Cameroun N ° 16, Annuaire des statistiques du secteur agricole campagne 2009 et 2010. 123.

Mouquet, C., Bruyeron, O., & Trèche, S. (1998). Dossier: Les Farines Infantiles. Bulletin N°15 Du Réseau Technologie et Partenariat En Agroalimentaire (TPA), 5-11.

Méndez-albores, A., Veles-medina, J., & Urbina-álvarez, E. (2009). Animal Feed Science and Technology Effect of Citric Acid on Aflatoxin Degradation and on Functional and Textural Properties of Extruded Sorghum, 150, 316-329. https://doi.org/10.1016/j.anifeedsci.2008.10.007

Obiakor-Okeke, P., Amadi, J. A., & Chikwendu J.N. (2014). Development And Evaluation of Complementary Foods Based on Soyabean, Sorghum and Sweet Potatoes Flours Blends. Food Science and Quality Management, 33(6), 77-87.

Ojo, O. (2015). The Challenges of Home Enteral Tube Feeding: A Global Perspective, 7, 2524-2538. https://doi.org/10.3390/nu7042524

Onabanjo, O. O., Akinyemi, C. O., & Agbon, C. A. (2009). Characteristics of Complementary Foods Produced from Sorghum, Sesame, Carrot and Crayfish. Journal of Natural Sciences, Engineering and Technology, 8(1), 71-83.

Osungbaro, T. O., Jimoh, D. O., & Osundeyi, E. (2010). Functional and Pasting Properties of Composite Cassava-Sorgum Flour Meals. Agriculture and Biology Journal of North America, 1, 715-720.

Ozola, L., & Kampuse, S. (2017). The Effect of Vacuum Cooking on Enteral Food Made from Fresh and Semi-Finished Ingredients. February, 208-214. https://doi.org/10.22616/rrd.23.2017.031

Ozola, L., Kampuse, S., & Galoburda, R. (2017). The Effect of High-Pressure Processing on Enteral Food Made From Fresh or Semi-Finished Ingredients. Foodbalt, 80-85. https://doi.org/10.22616/foodbalt.2017.008

Phillips, G. (2021). Introduction of Blended Diet for Enteral Tube Feeding in Paediatrics: A Case Report. Nutrition and Health - SAGE Journals, 0(0). https://doi.org/10.1177/02601060211054662

Ranganathan, V., Nunjundiah, I. T., & Bhattacharya, S. (2013). Effect of Roasting on Rheological and Functional Properties of Sorghum Flour. Food Science and Technology International, 11p. https://doi.org/10.1177/1082013213497210

Ratnavathi, C., & Chavan, U. D. (2016). Chapter 2: Malting and Brewing of Sorghum. Sorghum Biochemistry: An Industrial Perspective, 63-104. https://doi.org/10.1016/B978-0-12-803157-5.00002-2

Ru, L. (2021). Enteral Nutrition Tube with Anti-Blocking Function (p. Patent N° CN215022605).

Ruijie, L., Yiwen, G., Ming, C., Chengyu, Z., Xiaosan, W., & Xingguo, W. (2022). Total Nutrient Formula Food for Special Medical Purpose Suitable for Patients with Chronic Obstructive Pulmonary Disease.

Russo, R. D. (2022). High Flow Enteral Connector System (p. Patent N° GB2603535).

Sanoussi, A. F., Dansi, A., Dansi, M., Egounlety, M., Sanni, L. O., & Sanni, A. (2013). Original Research Article Formulation and Biochemical Characterization of Sweet Potato (Ipomoea Batatas) Based Infant Flours Fortified with Soybean and Sorghum Flours, 2(7), 22-34.

Schneider, S. M. (2006). Nutrition Entérale: quelle est sa place Dans Notre Arsenal Thérapeutique? Gastroenterology Clinique Biology, 30, 988-997. https://doi.org/10.1016/S0399-8320(06)73361-9

Shiriki, D., Igyor, M. A., & Gernah, D. I. (2015). Nutritional Evaluation of Complementary Food Formulations from Maize, Soybean and Peanut Fortified with Moringa oleifera Leaf Powder, 494-500. https://doi.org/10.4236/fns.2015.65051

Smith, L., & Garcia, J. (2011). 89 - Enteral Nutrition. In Pediatric Gastrointestinal and Liver Disease (4th ed., pp. 978-1001). Elsevier Inc. https://doi.org/10.1016/B978-1-4377-0774-8.10089-2

Susetyowati, Lestari, L. A., Setyopranoto, I., Astuti, H., & Wijayanti, P. M. (2019). Potential of Local Food-based Enteral Nutrition to Improve Patient' s Nutrition Status in Hospital in Yogyakarta. https://doi.org/10.12691/jfnr-7-8-3

Susetyowati, S., Sholikhati, A. S., Cahyaningrum, D. K., & Rachmawati, A. I. (2022). Provision of Local Food Based Nutrition Support to Adenocarcinoma Rectosigmoid Pre-Surgical Patient. Malaysian Journal of Medicine and Health Sciences, 18(1), 362-364.

Sutikno, V., Rahadiyanti, A., Fitranti, D. Y., Afifah, D., & Nissa, C. (2020). GLITEROS Enteral Formula Based on Tempeh Flour and Jicama Flour for Patients with Hyperglycemia. Food Research, 4, 38-45. https://doi.org/10.26656/fr.2017.4(S3).S17

Tizazu, S., Urga, K., Abuye, C., & Retta, N. (2010). Improvement of Energy and Nutrient Density of Sorghum- Based Complementary Foods Using Germination. African Journal of Food Agriculture, Nutrition and Development, 10(8), 2927-2942. https://doi.org/10.4314/ajfand.v10i8.60875

Trèche, S., & Mouquet-Rivier, C. (2008). Use of Amylases in Infant Food. In: Porta R, Di Pierro P, Mariniello L (eds) Recent Research Developments in Food Biotechnology. Enzymes as Additives or Processing Aids, Tirvandrum, 231-245.

Vieira, M. M. C., Santos, V. F. N., Bottoni, A., & Morais, T. B. (2018). Nutritional and Microbiological Quality of Commercial and Homemade Blenderized Whole Food Enteral Diets for Home-Based Enteral Nutritional Therapy in Adults.

Clinical Nutrition, 37(1), 177-181. https://doi.org/10.1016/j.clnu.2016.11.020

Walia, C., Rd, M. S., Cnsc, C. D., Hoorn, M. Van, Cd, R. D., Edlbeck, A., Rd, M. S., Cd, C. S. P., Beth, M., Ms, F., & Csp, R. D. (2016). The Registered Dietitian Nutritionist's Guide to Homemade Tube Feeding. Journal of the Academy of Nutrition and Dietetics. https://doi.org/10.1016/j.jand.2016.02.007

Wambugu, S. M., Taylor, J. R. N., & Dewar, J. (2003). Effect of Addition of Malted and Fermented Sorghum Flours on Proximate Composition, Viscosity, pH and Consumer Acceptability of Extruded Sorghum Weaning Porridges in Workshop on Protein of Sorghum and Millets: Enhancing Nutritional and Functional Properti, 15.

Weihong, F., Yan, G., Xuemei, S., Xiang, Z., Tingting, Z., & Xian, Z. (2022). Multifunctional Self-Flushing Type Constant-Temperature Enteral Nutrition Nasal Feeding Tube (p. Patent N° CN114795963)