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State of the art of Ready-to-Use Therapeutic Food: A tool for nutraceuticals addition to foodstuff

Antonello Santini [a,*], Ettore Novellino [b], Vincenzo Armini [b], Alberto Ritieni [b]

[a] Department of Food Science, University of Napoli "Federico II", Via Università 100, 80055 Portici (Napoli), Italy
[b] Department of Pharmaceutical and Toxicological Chemistry, University of Napoli "Federico II", Via D. Montesano 49, 80131 Napoli, Italy

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ABSTRACT

Therapeutic foodstuff are a challenge for the use of food and functional food ingredients in the therapy of different pathologies. Ready-to-Use Therapeutic Food (RUTF) are a mixture of nutrients designed and primarily addressed to the therapy of the severe acute malnutrition. The main ingredients of the formulation are powdered milk, peanuts butter, vegetal oil, sugar, and a mix of vitamins, salts, and minerals. The potential of this food are the low percentage of free water and the high energy and nutritional density. The high cost of the powdered milk, and the food safety problems connected to the onset of toxigenic moulds on the peanuts butter, slowed down considerably the widespread and homogenous diffusion of this product. This paper presents the state of the art of RUTF, reviews the different proposed recipes, suggests some possible new formulations as an alternative of novel recipes for this promising food.

1. Introduction

Data published by the Food and Agriculture Organization of the United Nations (FAO) relative to the trend of the hunger in the world from 2006 to 2009 are worrying: the number of individuals that suffer hunger increased of about two hundred millions, increasing from the about 850 millions in the year 2006 to almost one billion and fifty million in the year 2009. These data were partially modified in the year 2010, when the number of people suffering hunger in the world decreased to about one billion (Food and Agriculture Organization (FAO), 2010). It is also relevant to mention that children aged between zero and five, have a greater food need, due to both a greater energy and nutritional requirements, and to an immune system not completely developed yet. According to the (World Health Organization (WHO, UNICEF, & SNC, 2005)) and the United Nations Children's Fund (UNICEF, 2009) reports, about one hundred and fifty million of children from zero to five years are deeply underweight. Among these, about sixty millions are emaciated and/or are affected by various stages of malnutrition (World Health Organization, 2007; WHO, UNICEF, & SCN, 2006). About twenty millions suffer from severe acute malnutrition (SAM). The nutrients lack influence negatively all the body functions, dragging the individual to serious pathological conditions, e.g. edema, and death (World Health Organization, 2009). The fourth Millennium Development Goal (MDG), proposed to beat down of two third the mortality of the children under five years of age, in the time period from 1990 to 2015 and, although the good results achieved lately, the full achievement of the objective seems yet to be very far (Food and Agriculture Organization (FAO), 2010). The main factor that determined the failure of the interventions, in the last years is mainly due to the food used as approach to fight the malnutrition. Flour based foodstuff enriched of cereals and legumes, so far elective and preferred by the Governmental Organizations, are inappropriate with respect to some main problems that affect the most depressed areas of world, like the sub-saharian Africa and the southeastern regions of Asia. In these areas it should be taken into account, for example, the high environmental temperatures that favour the microbial proliferations in the food to be prepared or already cooked. Moreover, the water available to cook any food is often contaminated. It should be necessary to consider also that the populations insisting on these geographic areas of the world share culturally common practises of sharing foodstuff, being unaware of the most elementary rules of a correct hygienic routine. The onset in the last years of a new type of product called Ready-to-Use Therapeutic Food (RUTF) seemed to be a breakthrough for these problematic situations. This novel food mainly consists of peanuts, and is enriched with sugar, powdered milk, vegetal oil, vitamins, and mineral salts. Its peculiarity are: an high energy density (about 540 kcal/100 g), a complete nutritional contribution with mineral salts, vitamins, amino acids, and essential fatty acids, and a prolonged shelf-life with respect to

* Corresponding author. Address: Dipartimento di Scienza degli Alimenti, Università di Napoli "Federico II", Via Università, 100, 80055 Portici (Napoli), Italy. Tel./fax: +39 81 2539317.
E-mail address: asantini@unina.it (A. Santini).

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other products (up to 24 months due to the low percentage of water). Another major advantage of the RUTF composition is the possibility to use it on site within therapeutic programs, e.g. directly at home without the need to go to hospitals or to nutritional therapy centres for a proper use of this food. The RUTF, however, has also some problems. In the first place, the peanut butter can be contaminated by aflatoxins, carcinogenic molecules produced from *Aspergillus flavus* and *Aspergillus parasiticus* species toxigenic fungi, especially favoured when the cereals carioxides are not properly handled or stored (Awad, Ghareeb, & Böhm, 2012). Moreover, the presence of the powdered milk influences heavily (almost for one third) the final cost of the RUTF and, considering the price growing tendency of the raw material, in a few years the economical sustainability of this food would be compromised (UNICEF, 2009). For the above mentioned reasons, the scientific community should pledge itself in the development of new formulated RUTF, to reach higher safety standard and a proportional economic sustainability for the depressed areas where such product is destined. This paper is addressed to review and assess the available information, and to give some operating clues to try to give a strong stimulus for the search of alternative RUTF formulations that can include also nutraceutical compounds (Espín, García-Conesa & Tomás-Barberán, 2007) from vegetal origin (Wang & Weller, 2006), specifically addressed to health condition support and therapy. Nutraceuticals from natural sources have been investigated for their putative chemopreventive and cancer therapeutic properties for the last few decades. The interest in these compounds is in part due to their pleiotropic effects and relatively non-toxic nature and have recently become a hot topic for the commercial world and the biomedical community (Das, Eshani Bhaumik, Raychaudhuri, & Chakraborty, 2012). It is postulated that nutraceuticals are relatively non-toxic food supplements with many health benefits including prevention of cancer (Go, Harris, & Srihari, 2012). These aspects make them particularly appealing for the inclusion in RUTF formulations addressed to specific therapeutic use when needed.

2. RUTF: a new concept in food therapeutics

Since 1990, the need of a complete food necessary for underweight patients treatment stimulated the research of new formulations to fit the requirements of an high nutritional value food, easy to use and store and with minor risk due to possible contaminations and altering (Guimon & Guimon P., 2009; Hendricks, 2010). In 1997, Andrè Briend of the *Institut de Recherche pour Développment* of Parigi (France) and Michel Lescanne, of the *Nutriset* specialized in the field of nutritional food, prepared a cream enriched with nutrients to be used for the malnutrition acute syndrome in infants. This product a semi solid cream containing powdered milk, vegetal origin lipids, peanuts, sugar and minerals mixed with vitamins called Plumpy' Nut®, from the combination of two words: plump and peanut. This first prototype looked like a chocolate bar and had a composition similar to the therapeutic F-100 milk (100 kcals per 100 mL and high in energy, lipids, and protein content). The product was Ready-to-Use, did not need any preparation or cooking, and could be stored and consumed even with high outside temperatures. The bars however had an unpleasant taste when added with salts and vitamins, and had a low melting temperature (Guimon & Guimon, 2009).

In 2001, two years after the original idea development, the company Nutriset (http://www.nutriset.fr) started to produce this foodstuff and, at the same time, started a franchising market, transferring the production know-how of the Nutriset to industries directly operating in the Countries needing the product (Guimon & Guimon, 2012). The Plumpy' Nut® can be considered a typical RUTF. It is packaged in 92 g single unit packages, and has butter bar like aspect. The main ingredients are peanut butter, flour, sucrose, vegetal origin lipids, skimmed powdered milk, mineral salts and vitamins (A, C, D, E, B1, B2, B6, B12, biotin, folic acid, pantotenic acid, and niacin). Due to its high energetic content, about 500 kcal per 92 g package, this food allows to gain weight very fast, up to 500 g per week, as it would be necessary for a child to be treated for underweight pathology due to malnutrition (Nutriset, 2010). The daily dose to administer is about 200 kcal/kg per person, till the normal weight taking into account the age is achieved. Normally this happens in a 6–10 week time.

Table 1 reports the energetic-nutritional content and nutrients levels of the Plumpy' Nut®. The macronutrients average content can be indicated as lipids 36%, proteins 14%, carbohydrates about 43%. The biggest advantage of this foodstuff is that it does not need to be diluted with water and can be consumed directly from the envelope without the need to touch and possibly contaminate the content of the bag. Moreover, it can be stored for limited time for a subsequent use even if the bag has been previously opened. The extended shelf-life, about 24 months, as derived from manufacturing data (Nutriset, 2010), and the relatively small dimensions of each package make this product very easy to stock.

2.1. RUTF main components

Powdered milk is the main ingredient for the RUTF formulation. Even if milk sources are available worldwide, often this food is imported mainly in areas where cattle is difficult to breed. The normally adopted production techniques of long life powdered milk allow to guarantee its safe use to produce RUTF. Different vegetal oils could be used in the formulation, e.g. soy oil, cottonseed oil, colza or maize seeds oil. Considering however the balance of the essential fatty acids, the colza and soy oils seem to be the better ones in the RUTF formulations. Brown or refined fine powdered commercially available sugar (sucrose) can be used in the RUTF production. To facilitate the incorporation of the sugar particles in the fatty part of the RUTF the sucrose particles dimensions should be carefully controlled and stay below 200 μm. Peanut butter is obtained from high temperature toasted peanut seeds grinded without oil and with no addition of salt or preserving agents. Minerals and vitamins are added to the formulations as a complex of minerals and vitamins (CMV). The mixture of powdered vitamins and salts is the same used in the preparation of the F-100 milk. The CMV mixture it is usually the only imported main ingredient in the case of local production of the RUTF, while every other ingredient can be obtained from the local market, and mixed in the proportions according to the formulation to realise. The average composition (w/w) of a RUTF is 30% powdered whole milk, 28% powdered sucrose, 15% oil of vegetal origin, 25% peanut butter and 1.6% of CMV (Manary, 2006). From data reported in Table 1 it can be observed that the amount of each nutrient contained in the RUTF is higher with respect to the recommended daily allowance (RDA). This aspect is crucial as previously mentioned, when there is need to supplement the daily diet.

Table 2 reports the vitamin and mineral composition of the CMV complex on a 100 g basis. It can be observed that since the RUTF formulation are added usually with 1.6 g of the vitamin complex (Collins & Henry, 2004), the amount of vitamins and minerals supplemented is way above the RDA. Available data however do not refer to the same age group, making difficult to compare all available information. A relevant problem is connected to the raw products used. There could be a contamination risk due to the wrong manipulation of the raw materials, control programs in the production line should be implemented and monitored.