# Plant-Based Formulas and Liquid Feedings

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Plant based toddlers liquid feedings based on almond and buckwheat are available in some countries and online. A nutritionally adapted young child formula exists based on almond, buckwheat, and tapioca. Compared to other products, who are mainly based on a combination of isolated or fractionated nutrients, (i.e., combination of a protein ingredient, a fat ingredient, and a carbohydrate ingredient separately), this product uses whole foods, where nutrients are in their food matrix and the proteins are intact, minimizing the need of food processing.

toddler growing-up milk plant-based drink plant-based beverage plant-based formula young child formula

## 1. Soy Based Infant Formula and Drinks

Soy has been cultivated since the 17th century and is the third most important crop after rice and corn. Soy infant formula is historically the first plant-based feeding for infants and young children that was developed. The first use of soy based infant feeding was reported in the United States in 1909 [1]. Since the mid-1960s, the composition of soy based infant formula was adapted to the nutritional needs of infants [2]. Based on the National Health and Nutrition Examination Survey 2003–2010, 12% of infants aged 0–12 months old in the United States consume soy based infant formula [3]. The market share of soy based infant formula in New Zealand and Israel was reported to be 13% and 31.5%, respectively [4][5]. In 1929, soy based infant formula was introduced as a management option for infants with cow's milk allergy (CMA) [6]. Currently, this recommendation is abolished, and soy infant formula is no longer recommended as a first-choice option in the management of infants with CMA, although often proposed as second option in many guidelines [7].

Soybean is a good source of protein. Protein content in raw soybean is around 40%, and is higher than other macronutrient content such as carbohydrate (25%) and fat (20%). Different from regular soy beverages that use raw soybean as its ingredient, soy based infant formula uses soy isolate protein. Soy isolate protein is processed from soybean by eliminating other nutrients to yield a high purity protein product that contains at least 90% of protein and maximum 1% of fat, 0.2% of crude fiber, 4% of carbohydrate [8][9]. Heat treatment and extraction during the processes are also lowering some unfavorable ingredients, such as isoflavones, trypsin inhibitor, phytic acid content and the beany flavor [10][11]. Soy protein isolate has a protein digestibility-corrected amino acid score (PDCAAS) of one which is comparable to high quality animal protein such as casein and egg white [12]. Natural fiber in soy, such as raffinose and stachyose, can cause infants to have unpleasant semiliquid stools or flatulence [10]; therefore, removing natural fiber during the process to produce soy isolate protein could be advantageous. To

fortify soy protein isolate formula, the use of other types of fiber, such as fructooligosaccharides, which have a prebiotic effect, is more beneficial [13]. Fructo-oligosaccharides originate from plants and consequently do not contain traces of milk as might occur with galactooligosacharide originating from cow's milk. The prebiotic effect helps maintain a healthy gastrointestinal environment by selectively stimulating the growth of nonpathogenic bacteria, such as bifidobacterial, and increase the frequency of defecation and decrease stool consistency [14][15][16][17].

Nevertheless, the remaining uncertainties regarding isoflavones, the phytoestrogen content, the presence of a trypsin inhibitor and the beany flavor made soy infant formula disappear from the European market. However, soy drinks for toddlers remain available, and are frequently used in toddlers and children with lactose intolerance. Besides availability and palatability, personal beliefs, religious background, and contemporary views advocating the importance of plant-based food in the adult population also influence the nutritional choices parents make for their offspring [18]. Soy protein, and thus with phytoestrogens, and soy isolate protein, and thus without phytoestrogens, are both used in toddler's soy drinks. Therefore, while some soy-drinks on the market are not nutritionally adapted to the needs of toddlers, others are adapted, creating confusion for the health care provider and consumer, indicating the need for a different name and classification.

## 2. Rice Based Infant Formula and Drinks

Worldwide, rice is the most cultivated crop. Health care providers and parents are familiar with hydrolyzed rice-based infant formula for the treatment of CMA. Hydrolyzed rice infant formulas are present in many European countries since more than 30 years, and occupy a significant market share [19]. The consumption of hydrolyzed rice protein formulas accounted in 2018 in France for almost 5% of all formulas for children aged 0–3 years [20]. Initially this rice-based hydrolysate was significantly cheaper than cow's milk based extensive hydrolysates, but this difference in cost has disappeared in many countries, while it persisted in others.

Hydrolyzed rice formula was shown to be safe, nutritionally adequate and tolerated by infants allergic to cow's milk and soy formula [16][18][19]. Infants fed a rice hydrolysate for 6 months were shown to have normal growth, normal plasma biochemical levels, and no adverse reactions were seen. Hydrolyzed rice infant formula was proposed to be more effective than soy and comparable to a casein hydrolysate in infants with CMA [21]. No significant differences between a rice hydrolysate, soy infant formula and extensive casein hydrolysate groups were observed for the z-score of weight for age during the first two years of life and for nutritional serum parameters such as plasma total protein, albumin, prealbumin, calcium, magnesium, and alkaline phosphatase [21][22][23][24].

Unlike the rice-protein based infant formula, rice beverages made from rice flour are nutritionally inadequate for infants. The amino-acid lysine is deficient in rice protein, and is supplemented in rice based infant formula. The high content of arsenic in some rice cereals and other rice products received a lot of attention [25][26]. The Food and Drug Administration in the USA and the Nutrition Committee of ESPGHAN warned also about the high arsenic content in some rice products [26][27]. However, the arsenic content in rice formula was reported to be very low, and not different from the arsenic content of cow's milk based infant formula [28].

Today, the conclusion about rice hydrolysate infant formula does not differ a lot from the conclusion from the "*Diagnosis and Rationale for Action against Cow's Milk Allergy*" (DRACMA) guidelines published in 2010: rice protein based infant formula may provide a potentially adequate alternative if standard milk- or soy protein-based formulas are not tolerated [29]. Therefore, we endorse the conclusions of the recently published position paper of the Committee on Nutrition of the French Society of Pediatrics (CNSFP): Hydrolyzed rice protein formulas are proposed as a plant-based alternative to cow's milk protein-based extensively hydrolyzed formulas (CMP-eHF) [30]. Hydrolyzed rice protein formulas do not contain phytoestrogens and are derived from non-genetically modified rice [31][32]. Hydrolyzed rice formula ensures satisfactory growth from the first weeks of life for infants and toddlers, both in healthy children and in those with CMPA, and they can be used to treat children with CMA either straightaway or in second intention in cases of poor tolerance to CMP-eHF for organoleptic reasons or for lack of efficacy [33].

Last but not least, cost and acceptability should as well be considered. Overall, rice hydrolysates are reported to have a better taste, although this has not been scientifically validated. In countries were CMP-eHFs are not reimbursed by the National Health System, cost of formula does play a major role in determining the final choice. A recent consensus paper positioned hydrolyzed rice formula as an alternative to CMP-eHF as first option in the dietary management of infants with CMA in the Middle East, North Africa, and Pakistan Region [31].

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