



Letter

Blinded sensory evaluation of extensively hydrolyzed formulas and amino acid formulas

Challenge-confirmed European studies have estimated that 1.9% to 4.9% of infants develop cow's milk allergy.¹ Extensively hydrolyzed formulas (eHFs) are normally recommended as first choice, and amino acid–based formulas (AAs) are recommended in more severe cases, and when eHFs are not tolerated, for the treatment of cow's milk allergy in non-breastfed children.¹ The eHFs and AAs are notorious for their unpleasant bitter and sour taste and nauseating smell and aftertaste owing to the presence of peptides and amino acids.² Prenatal and early life sensory experiences influence food preferences early and later in life. These experiences have an effect on children's food acceptance and the variety of foods consumed can have an impact on infant health.^{2–5} The unpleasant palatability of infant eHFs and AAs could negatively affect the development of taste and food preferences in food-allergic children. Allergy specialists, pediatricians, and dietitians often observe picky eating behavior in these children.⁶

Some health care professionals (HCPs) believe that the taste of an AA is even worse than the taste of an eHF. However, to our knowledge, the palatability of different brands of eHF and AA have not been directly compared by sensory testing. The aim of this study was to evaluate the palatability of an eHF based on whey (eHF-W; Nutrilon Pepti, Nutricia, Zoetermeer, the Netherlands), an eHF based on casein (eHF-C; Nutramigen, Mead Johnson, Glenview, Illinois), and an AA (Neocate, Nutricia Advanced Medical Nutrition, Utrecht, the Netherlands) in adults.

In 2011, we performed sensory testing in 40 European HCPs. Twenty-three HCPs participated in the initial sensory testing of the overall palatability of the 3 different infant formulas. The overall palatability of the formulas was scored using the visual analog scale (VAS; 10 cm: 0 = dislike extremely, 10 = like extremely).

For the specific sensory testing of the formulas, subgroups of 8 to 11 HCPs each evaluated a formula for bitterness, sourness, sweetness, mouth feel, and aftertaste using a 10-cm VAS. This study was exempt from medical ethical approval.

Statistical analyses were performed by the Wilcoxon signed rank test for overall palatability (23 HCPs testing all formulas) and the Mann-Whitney test for specific sensory testing (subgroups of 8 to 11 HCPs, with each testing 1 of the formulas) using SPSS 19 (SPSS, Inc, Chicago, Illinois).

The median VAS scores for overall palatability as assessed by the 23 HCPs were ranked according to the median VAS scores: 5.8 (interquartile range 4.6–7.5) for eHF-W, 2.1 (1.1–3.5) for AA, and 1.0 (0.3–2.5) for eHF-C. The HCPs judged the overall palatability of the eHF-W as significantly better than the AA ($P = .000$) and eHF-C ($P = .000$). No significant differences were found between the eHF-C and

the AA (Table 1). The median VAS scores for bitterness, sourness, sweetness, mouth feel, and aftertaste are listed in Table 1. Bitterness, sourness, mouth feel, and aftertaste were scored significantly less strongly for the eHF-W than for the eHF-C and the AA. These sensory characteristics could not be masked by the greater sweetness of the eHF-C.

The present results are in line with those of a study by Pedrosa et al⁷ who compared the overall palatability of 12 standard bottle formulas, including partial hydrolysates, eHF-Cs, eHF-Ws, mixed casein–whey formulas, hydrolyzed and nonhydrolyzed soy formulas, and rice milk formulas in a panel of 50 volunteers in a double-blinded setting. The soy and rice formulas had the best taste scores, followed by the eHF-Ws, and the mixed hydrolysates. The eHF-Cs had the lowest taste scores. They did not include an AA in their comparisons. To our knowledge, no other studies have compared the sensory characteristics between an eHF and an AA. The present study showed that the assumption that the taste of an AA is worse than the taste an eHF was only partly confirmed. The AA scored not significantly better than the eHF-C, but significantly worse than the eHF-W.

Ideally, this study should have been performed in children. Because we expected that nonallergic children would refuse to taste these foods and thus not allow us to test them thoroughly, we selected adults for testing.

It is still unknown whether the use of bitter- and sour-tasting eHFs and AAs influence food preferences and food choice later in life. Many factors can contribute to taste development and food like or dislike. First, flavor perception in humans is strongly influenced by inborn factors.⁸ However, learning new flavor preferences can occur across the lifespan, but early flavor experiences have more permanent effects.⁹ Second, after birth, in breastfed infants, flavor learning is further enhanced by the exposure to a large variety of flavors in breast milk, which is influenced by the dietary choices of the nursing mother.⁴ In bottle-fed infants, it has been shown that in the first 3 to 4 months of life are sensitive learning periods during which unpalatable flavored foods, such as eHFs and AAs, are readily accepted by the infant.² Older infants, not previously exposed to eHFs, strongly reject these formulas.¹⁰ Children who are exposed to an eHF and an AA may appreciate bitter- and sour-tasting foods, such as sour- and bitter-flavored apple juice and broccoli, better than children who received a milk-based food during infancy.⁵

The next step will be to prospectively investigate the use of eHFs and AAs on the development of food preferences in the long term and determine whether they are associated with picky eating behavior in food-allergic children. In conclusion, we found that the eHF-W tested had a better taste than the tested eHF-C and AA. Many factors contribute to the taste development of the child, and

Disclosures: Dr Sprinkelman received a research grant from Danone Research NE.

Table 1

Median VAS scores by health care professionals in descending sequence and sensory characteristics of eHF-W, eHF-C, and AA

VAS scores (cm) by health care professionals in descending sequence, median (IQR)						
Formulas	eHF-W		AA		eHF-C	
VAS scores	5.8 (4.6–7.5)		2.1 (1.1–3.5)		1.0 (0.3–2.5)	
Sensory characteristics of eHF-W, eHF-C, and AA						
	eHF-W	P value, eHF-W vs eHF-C	eHF-C	P value, eHF-W vs AA		P value, eHF-C vs AA
Bitterness	7.7 (6.4–10.0)	.001 ^a	1.1 (0.3–2.7)	.018 ^a	2.7 (1.6–6.2)	.093
Sourness	7.4 (5.9–9.7)	.010 ^a	2.5 (1.1–6.6)	.037 ^a	5.0 (2.6–8.7)	.211
Sweetness	7.7 (5.2–9.2)	.202	9.5 (7.0–10.0)	.789	6.7 (6.1–7.5)	.094
Mouth feel	7.6 (5.8–9.2)	.009 ^a	2.3 (0.6–4.3)	.033 ^a	5.4 (2.3–6.2)	.100
Aftertaste	7.4 (2.8–9.1)	.017 ^a	2.2 (0.8–2.8)	.126	5.2 (2.1–6.4)	.120

Abbreviations: AA, amino acid–based formula (Neocate); eHF-C, extensively hydrolyzed formula based on casein (Nutramigen); eHF-W, extensively hydrolyzed formula based on whey protein (Nutrilon Pepti); IQR, interquartile range; VAS, visual analog scale.

^aP < .05.

the influence of an eHF or an AA is not necessarily negative for taste development in these children.

Nicolette W. de Jong, PhD, BEd*
 Aline B. Sprikkelman, PhD, MD[†]
 Hanneke N.G. Oude Elberink, PhD, MD[‡]
 Nicolette J.T. Arends, PhD, MD*
 Berber J. Vlieg-Boerstra, PhD, RD[†]
 *Department of Internal Medicine
 Section of Allergology, Erasmus MC
 Rotterdam, The Netherlands

[†]Department of Pediatric Respiratory Medicine and Allergy
 Emma Children's Hospital
 Academic Medical Center
 University of Amsterdam
 Amsterdam, The Netherlands
[‡]Department of Allergy
 University Medical Center Groningen
 University of Groningen
 Groningen, The Netherlands
b.j.vlieg-boerstra@amc.uva.nl

References

- [1] Fiochhi A, Brozek J, Schünemann H, et al. World Allergy Organisation (WAO) diagnosis and rationale for action against cow's milk allergy (DRACMA) guidelines. *Pediatr Allergy Immunol*. 2010;21(suppl):1–125.
- [2] Mennella JA, Beauchamp GK. Understanding the origin of flavor preferences. *Chem Senses*. 2005;30(suppl 1):i242–i243.
- [3] Mennella JA, Jagnow CP, Beauchamp GK. Prenatal and postnatal flavor learning by human infants. *Pediatrics*. 2001;107:E88.
- [4] Beauchamp GK, Mennella JA. Flavor perception in human infants: development and functional significance. *Digestion*. 2011;83(suppl 1):1–6.
- [5] Mennella JA, Beauchamp GK. Flavor experiences during formula feeding are related to preferences during childhood. *Early Hum Dev*. 2002;68:71–82.
- [6] FARE: Food Allergy Research and Education. Web site. <http://www.foodallergy.org>. Accessed June 20, 2014.
- [7] Pedrosa M, Pascual CY, Larco LI, Esteban MM. Palatability of hydrolysates and other substitution formulas for cow's milk-allergic children: a comparative study of taste, smell, and texture evaluated by healthy volunteers. *J Investig Allergol Clin Immunol*. 2006;1:351–356.
- [8] Bartoshuk LM, Beauchamp GK. Chemical senses. *Annu Rev Psychol*. 1994;45:419–449.
- [9] Galloway AT, Lee Y, Birch LL. Predictors and consequences of food neophobia and pickiness in young girls. *J Am Diet Assoc*. 2003;103:692–698.
- [10] Mennella JA, Beauchamp GK. Developmental changes in the acceptance of protein hydrolysate formula. *J Dev Behav Pediatr*. 1996;17:386–391.