facts

Formulating better tasting infant formula

Jungbunzlauer

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Abstract

This technical paper provides detailed insights into a new approach to addressing taste defects in high protein products such as infant formula. Hypoallergenic formula is particularly susceptible to exhibiting an off-taste, especially in the form of bitterness which can negatively influence the acceptability of the formula for both the baby and the parents.

The first step involved purchasing one standard (Pre) and six hypoallergenic powder infant formulas (Pre, HA1, HA2) from German retail markets which were then pre-screened by a small panel for off-taste with a focus on bitterness in the ready-to-drink (RTD) sample. Surprisingly, all seven samples were rated as bitter, while five were even considered to be very bitter.

Two of the samples were selected for in-depth evaluation by the Jungbunzlauer sensory panel using simple descriptive, ranking and paired comparison tests. Four organic minerals approved for infant and follow-on formula, i.e. trisodium citrate, tripotassium citrate, trimagnesium citrate and sodium gluconate, were added to the infant formula powder samples which were then prepared as RTD according to the label information. Significant reductions of bitterness were achieved with trisodium citrate (0.08% and 0.15% concentration in RTD) and the other salts also showed an improvement of the taste profile at these comparably low dosages.

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Introduction

Jungbunzlauer is among the leading global manufacturers of organic minerals which are supplied to the pharmaceutical and food industry. Table 1 lists its relevant minerals for infant formula as being one of the key food applications. These salts are all derived from citric acid and preferred in infant formula due to their benefits concerning safety and purity, advantages for wet and dry mix and also due to their superior taste compared to inorganic minerals. Although not used in infant formula yet, sodium gluconate was included in the trials due to its proven bitterness reduction properties in food applications such as beverages.

Table 1: Overview of Jungbunzlauer minerals generally used in infant formula and/or used for the trials (all salts are approved minerals for infant formula and baby food according to Codex and EU legislation)

Mineral salt	Abbr.	Solubility (g/l)	Used in trials	Comment
Sodium Gluconate	SG	600	yes	Not commonly used in infant formula yet
Trisodium Citrate	TSC	420	yes	
Tripotassium Citrate	TPC	1780	yes	
Tricalcium Citrate	TCC	1	no	Not tested as solubility likely too low to mask taste defects of other components
Trimagnesium Citrate	TMC	200	yes	
Zinc Citrate	ZC	3	no	Not tested as being microelement

Infant formula can display off-taste issues such as bitterness, which are not only due to the use of inorganic minerals such as chlorides, sulphates or phosphates, but also due to the presence of specific proteins and peptides. This can be a challenge as babies may resist consuming the reconstituted milk, but also for the parents who make the purchasing decision and may find the product to be unsuitable for feeding.

Hypoallergenic formula contains peptides (from the enzymatic hydrolysis of proteins), which are known to display a specific bitter taste. There are several methods of debittering protein hydrolysates, such as selective separation and further enzymatic treatment [1]. However, to our knowledge no suitable technique is available for powdered infant formula. Additionally, there is usually no option to add flavours or masking agents (as can be done for high protein sports food for example) due to the restrictive legislation for infant formula.

The objective was therefore to
- Identify suitable market samples of infant formula with off-taste, focussing on hypoallergenic products
- Define suitable attributes for off-taste
- Check if trisodium citrate, tripotassium citrate or trimagnesium citrate, which are already used as a mineral source in infant formula can additionally reduce off-taste. As an add-on, sodium gluconate was included in the tests as it is already used for bitterness reduction and taste improvement in beverages and food supplements

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Technical approach: Evaluating the challenge

To gain knowledge about the taste characteristics of powder infant formulas, a store check was conducted in four local German retail markets and seven samples were selected. These samples differed in company, brand and target group (see Table 2), with one being standard and six being hypoallergenic infant formula. This means that the milk protein was replaced by protein hydrolysates for better digestibility and less allergic reactions.

Table 2: Overview of tested commercial powdered infant formula samples

Category	Pre	HA Pre			HA 1		HA 2
Target group	0-6 months	0-6 months, allergy sensitive			0-6 months, allergy sensitive		> 6 months, allergy sensitive
Market sample	1	2	3	4	5	6	7
Bitter	yes	yes	yes	yes	yes	yes	yes
Selected for further trials	–	X	–	–	–	X	–

Legend: Bitterness slight medium strong

The first step involved reconstituting the seven samples with plain water according to the provided label instructions and pre-screening them at room temperature for off-taste with a focus on bitterness. Surprisingly, all seven samples were rated as bitter, while five were even considered to be very bitter. The two most bitter and least preferred in taste were chosen for further and more detailed studies in order to find the Jungbunzlauer solution for reducing off-taste and especially bitterness.

Following this step, a simple descriptive test was conducted by the Jungbunzlauer sensory panel (10 to 22 trained participants), starting with the reconstituted market sample No. 2. As a result, the panellists narrowed down the most dominant off-taste attributes to bitter, metallic and rancid.

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Providing a solution with minerals

Considering that the predominant taste issue of hypoallergenic infant formula is its bitterness, the objective was therefore to reduce any bitter taste whilst ideally masking other off-notes, such as metallic and rancid taste.
Four organic minerals approved for infant and follow-on formula, i.e. trisodium citrate, tripotassium citrate, trimagnesium citrate and sodium gluconate, were now added to the infant formula powder samples which were then prepared as RTD according to the label information. With the previously chosen off-taste attributes, the panel was tasked with performing a ranking test. The outcome of this test was that the metallic and rancid taste showed no clear ranking tendencies, whereas the ranking for the attribute bitter was significant (see Table 3).

Table 3: Results of the ranking test for the attribute bitter in infant formula (IF) No. 2. Sum of ranks (Friedman): not bitter = 1; bitter = 5; asterix (*) = significant ($\alpha = 0.05$)

Mineral salt	Mineral addition	No.of participants	Sum of ranks	Rank
IF Standard	none	17	61	5
IF+TMC	0.15%	17	58	4
IF+TPC	0.15%	17	55	3
IF+SG	0.15%	17	54	2
IF+TSC	0.15%	17	27	*1

It could particularly be shown that trisodium citrate significantly reduced bitterness in the formulation and that the standard was perceived as most bitter.

An interesting outcome were the comments of some panellists, which described the samples with added minerals as overall having an improved taste profile (see comments in table 4).

Table 4: Comments by panellists from sensory evaluation of infant formula No. 2 before and after mineral addition

Before mineral addition	Mineral (0.15%)	After mineral addition
Bitter, metallic, rancid, bloody, fishy, salty, grainy, malty	+ TSC	buttery, sweet, round
	+ SG	mild, milky, creamy, slightly salty
	+ TPC	slightly sweet
	+ TMC	sweet, milky, sweet-sour note, nutty

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Refining the taste improvement properties of mineral salts

The next step was to apply a paired comparison test to check for significant differences concerning bitterness when minerals are added at 0.15%, but possibly also at lower dosage levels. In this case, trisodium citrate showed a significant improvement of bitter taste both at 0.15% and even 0.08% in infant formula No. 2 and clear tendencies to positively affect the bitterness sensation when tripotassium citrate, trimagnesium citrate and sodium gluconate were used (Figure 1, red columns).

To prove the versatility of this novel taste improvement concept, the knowledge was transferred to the second chosen infant formula product of the pre-screening (sample 6 in Table 2). This product was hypoallergenic as well, but for a different target group and from a different company. The abilities of trisodium citrate, tripotassium citrate, trimagnesium citrate and sodium gluconate to effectively alter the bitterness sensation of hypoallergenic infant formula could again be verified (Figure 1, blue columns).

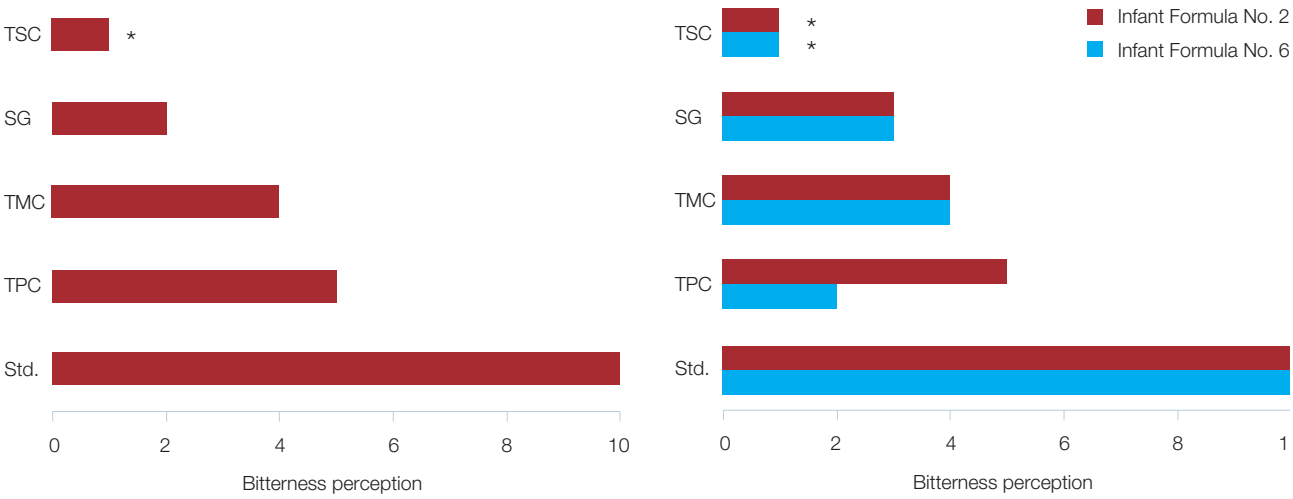

Figure 1: Bitterness perception of two different infant formula RTD with added minerals at 0.15% (left) and 0.08% (right) compared to standard (Std.)
Asterix (*) = significant difference according to two-tailed paired comparison test ($\alpha = 0.05$).

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Considering the effect on total mineral content and pH

In this study the evaluation of effects of minerals on taste improvement refers to the additional implementation in the ready-to-drink product. It is therefore necessary to consider the amount of additional sodium, potassium and magnesium as it distinctly changes the nutritional profile of the formulation. The impact on the mineral content in RTD and powder infant formula can be seen in Table 5.

Table 5: Impact of on-top addition of mineral salts on the mineral content of ready-to-drink and powder infant formula

Mineral salt		Sodium gluconate		Trisodium citrate		Tripotassium citrate		Trimagnesium citrate	
Mineral		**Na**		**Na**		**K**		**Mg**	
Mineral content in salt added	%	10.6		26.0		36.0		16.0	
Added concentration of mineral salt in 100g RTD	%	0.08	0.15	0.08	0.15	0.08	0.15	0.08	0.15
Additional mineral content in 100g RTD	mg	8.48	15.90	20.79	39.00	28.79	54.00	12.79	24.00
Additional mineral content in 100g dry powder	mg	63.75	119.60	156.38	293.35	216.52	406.17	96.23	180.52

The herewith associated changes in the pH were also measured during trials. The pH of the standard was 6.8 (infant formula No. 2) respectively 6.7 (infant formula No. 6). After addition, the pH changed slightly within a range of 0.1 and was not seen as being relevant for impacting taste.

Summary and conclusion

Significant reductions of bitterness were achieved with trisodium citrate when added on top of powdered infant formula at 0.08% and 0.15% concentration in RTD. The other citrate or gluconate salts tested also showed improvement of the taste profile at these comparably low dosages. As mineral content is regulated, this enables a choice of minerals beyond trisodium citrate to address, for example, sodium free requests or to keep the specific mineral level within the required range.

Besides bitterness reduction, it could be found that in some cases the minerals can also alter the taste profile to, for example, a more round or creamy flavour. This novel approach for bitterness reduction and taste modification is relevant because flavours are typically not allowed and more attention can therefore be paid to the choice of minerals when optimising the taste of infant formula. Ultimately, better tasting formulas improve the chances of the baby accepting the product and may also positively influence the purchasing decision of the parents.

Further tests are foreseen to check mechanisms and the ability of taste improvement in high protein food products in general.

References

(1) Saha BC, Hayashi K Debittering of protein hydrolyzates, Biotechnology Advances 19 (5), 355–370 (2001)

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