Jungbunzlauer

From nature to ingredients®

facts

A natural chewing experience: Chewing gum with ERYLITE® Erythritol

Introduction

The mysterious product chewing gum has fascinated mankind already for centuries. As well as providing a pleasant experience, chewing gum has been shown to have beneficial effects on concentration and cognitive function, as reported in several studies.[1] While early forms of chewing gum relied on tree resin (e.g. chicle) and waxes, the development of synthetic gum bases has since enabled the market to flourish and diversify into all sorts of colours, forms, flavours, textures and functions. Nevertheless, the basic principle remains the same: A water-insoluble phase delivers the chewing body, while the water-soluble phase provides sweetness and flavour.

The water-insoluble gum base is a complex matrix of ingredients whose exact composition is usually a well-protected trade secret. Key ingredients include elastomers, solvents, polymers, and emulsifiers, but waxes, plasticisers and fillers also contribute to a unique matrix whose mouthfeel, hardness, stickiness and flavour binding capacity is influenced by the choice and exact amount of each component.[2,3] Interestingly, the water-soluble phase can influence the texture of the final product despite being added to a gum base that is already pre-mixed. This phase consists mainly of sweeteners, humectant, and flavours. The amount of the individual ingredients is key, but additionally, the water content of the components or the granularity of the sweetener may influence the hardness of the gum.[4] In the case of sugar-free chewing gums, the sweeteners are usually a composition of different polyols combined with high intensity sweeteners to achieve the best possible sweetness profile. This complex combination of ingredients was a challenge for this project.

ERYLITE® and the growing demand for natural chewing gums

Conventional chewing gums, with matrices based on synthetic polymers such as polyvinyl acetate, cannot be classed as natural products.[5] Moreover, synthetic chewing gums of this type are not biodegradable and can leave ugly residues in public places such as pavements, even prompting discussions about a “chewing gum tax” in Great Britain in 2021.[6] This, together with the general increase of consumers’ interest in natural ingredients and their awareness of the contents of their food, is opening up new opportunities for natural gum bases. A chewing gum can only be marketed as a natural product if all of its ingredients meet certain criteria, increasing the need for natural sweeteners.

Jungbunzlauer’s ERYLITE® erythritol is a polyol manufactured by fermentation from glucose syrup, which is obtained from maize. Since the fermentation process does not involve genetically modified organisms, and the use of chemicals is avoided during processing, Jungbunzlauer considers ERYLITE® to be a natural sweetener. The idea of using erythritol in chewing gum is not new, but its use was widely patented in the early nineties, significantly restricting the development of new recipes over a prolonged period. However, many of those patents have expired over the past 15 years and all of the major market players have launched chewing gums containing erythritol. The aim of the studies reported in this article was to illustrate the basic functionalities of ERYLITE® as an ingredient of chewing gum.

Erythritol provides only about 60% of the sweetness of sugar, so high-intensity sweeteners such as stevia need to be added to augment the sweetness in most cases. Even so, the negative heat of solution generated by ERYLITE® makes it an interesting candidate for inclusion in chewing gum. The dissolution of ERYLITE® induces a cooling effect in the mouth, which pairs well with mint flavours. We decided to use xylitol as a reference polyol for our experiments, because it demonstrates a similar cooling effect and appeared to exhibit the greatest similarity with ERYLITE® out of all the polyols currently used in the chewing gum industry.

Development of chewing gum recipes

Two recipes were developed (table 1) using a natural chicle gum base and a synthetic gum base which are commonly used in the confectionery industry. Both of these recipes contain Jungbunzlauer's ERYLITE® in combination with stevia rebaudioside A (RebA) to adjust the sweetness. Jungbunzlauer produces ERYLITE® F8030 granules, with max. 25% of particles above 800 µm and max. 10% below 300 µm. However the ERYLITE® was milled and sieved to obtain the finer particles required for a chewing gum with pleasant mouthfeel and chewing experience. Only particles smaller than 150 µm were used in the recipe.

Table 1: Chewing gum recipe with synthetic and natural chicle gum

Synthetic gum base		
	[g]	[%]
ERYLITE®	**610.00**	**60.65**
Stevia RebA	0.732	0.07
Synthetic gum base	300.00	29.83
Maltitol syrup	50.00	4.97
Glycerine 99.5%	15.00	1.49
Lecithin	5.00	0.50
Mint flavour (liquid)	5.00	0.50
Peppermint flavour (solid)	7.50	0.75
Mint flavour (solid)	12.50	1.24
Zinc Citrate Dihydrate*	**0.049**	**0.005**
Total	1006	100

Chicle gum base		
	[g]	[%]
ERYLITE®	**640.00**	**63.63**
Stevia RebA	0.768	0.08
Natural chicle gum base	300.00	29.83
Glycerine 99.5%	40.00	3.98
Mint flavour (liquid)	5.00	0.50
Peppermint flavour (solid)	7.50	0.75
Mint flavour (solid)	12.50	1.24
Zinc Citrate Dihydrate*	**0.049**	**0.005**
Total	1006	100

*Zinc Citrate Dihydrate or Zinc Lactate were only tested for off-notes in a sensory screening as indicated and not contained in the standard recipe.

As mentioned in the introduction, each of the ingredients in a chewing has a specific function and is therefore essential to the composition. Glycerine acts as a moisturiser and prevents the chewing gum from drying out. Maltitol syrup is a sugar-free alternative to glucose syrup. It also serves as a binding agent and plasticiser. Furthermore, it gives texture to the chewing gum. The chicle gum base is inherently soft and elastic, therefore it was not necessary to add maltitol syrup to the chicle gum.
A mixture of liquid and powdered mint flavours provided a pleasant, fresh aroma. The flavourings also function as plasticisers. Lecithin additionally supports the homogenous distribution of the flavour and plasticisers.

Preliminary trials were conducted on the fortification of these two chewing gum products with zinc, using 15% of the recommended nutrient reference value (NRV) per 100 g product. Jungbunzlauer zinc salts are often used in dental care products such as toothpastes, mouthwashes and chewing gums due to their antimicrobial and anti-inflammatory effects and its ability to reduce or inhibit the formation of dental plaque and tartar. Jungbunzlauer produces zinc lactate and zinc citrate, which differ in terms of mineral content and solubility (zinc lactate is 23% zinc with a solubility of 55 g/L; zinc citrate dihydrate is 32% zinc with a solubility of 2.6 g/L). Fortification with minerals may alter the taste of the final product, and this must be taken into consideration when formulating the product. However, the recommended NRV for zinc is very low, thus only small amounts are needed to fulfil oral hygiene benefit claims.

Production process

Synthetic gum base and maltitol syrup were mixed using a Z-type kneader. One third of the ERYLITE® was added and kneaded for 10 minutes. Another third of ERYLITE® was then mixed in followed by glycerine and the rest of the ERYLITE®. Finally, lecithin and flavour were added.

The chicle-based chewing gum was prepared in a similar way but without the maltitol syrup and lecithin, starting with mixing the gum base and glycerine. One third of the ERYLITE® amount was then added and kneaded for 10 minutes followed by the remaining ERYLITE® and flavouring added at the end. The chewing gum mass was rolled out with talcum to prevent sticking and cut into strips.

For analytical comparison, chewing gums containing xylitol were produced instead of ERYLITE® using a similar procedure.

Analysis methods for chewing gum

Shelf-life test and storage

Chewing gum strips of each recipe were stored unpacked under different climatic conditions (different temperatures and relative humidities (RH)) for two months:

- Temperate condition: Room temperature (21°C); 40 – 60% RH
- Subtropical/Mediterranean condition: 30°C, 50% RH
- Hot/humid condition: 30°C, 65% RH

Chewing gums can dry out or bind water, which causes them to lose or gain weight and shorten their shelf life. The samples were weighed regularly to document the changes in mass, which are associated with instability.

Texture analysis

Chewing gums were cut into strips of the same dimensions (40 mm x 15 mm x 2 mm) and pre-heated to 50°C in a climatic cabinet. Shortly before the measurement started, the samples were removed and fixed centrally to a sample platform and hook. Analysis started at 35°C ± 2°C, simulating oral temperature.
Once a trigger force of 5 g was attained, the hook was used to extend the chewing gum sample until its elastic limit (at maximum force) was exceeded and the sample broke. At this point, force and distance were noted and used as an indication of chewing gum extensibility. The maximum force required to break the chewing gum into two pieces is expressed as "resistance to extension". The degree or distance to which a product can be extended before it breaks is referred to as "extensibility" and correlates to the elasticity of a product.[7] The texture analysis was carried out ten times per recipe.

Sensory evaluation

Jungbunzlauer's internal sensory panel conducted an initial sensory screening of chewing gums using the "just-about-right" (JAR) scale. This provided information on perceptions of texture, sweetness as well as flavour intensity and cooling sensation, and their possible impact on acceptance of the various products. Attributes were evaluated over time starting at 10 seconds and ending after 120 seconds of chewing. Panellists had to evaluate whether the intensity of each attribute is perceived as "just right", as opposed to either too much, not enough, too soft or too hard.

A further discriminative evaluation (paired comparison tests) was conducted. The panellists directly compared the two versions in terms of hardness, sweetness and cooling effect.

19 to 26 panellists participated in the sensory sessions and the significance level applied for statistical analysis was set at α=0.05.

Finally, chewing gums to which zinc salts had been added manually were also evaluated for off-notes. Zinc lactate and zinc citrate were mixed into the synthetic-based chewing gum with ERYLITE®. This sensory session with 12 participants took place under informal conditions and expressiveness is therefore limited. Nevertheless, the data provides an initial indication of the impact of zinc salts on the taste of chewing gums with ERYLITE®.

Results and Discussion

Storage tests

The results of the storage tests are shown in the following graphs. All chewing gums changed weight during the storage time, independently of the gum mass or polyols. The highest mass changes, ranging from 2.6% to 4.6%, were observed under hot/humid conditions (figure 3). During storage under subtropical conditions (figure 2) and at room temperature (figure 1) mass changes were very small for all samples, with a maximum weight change of 1.75% (chicle gum base with ERYLITE® or xylitol).

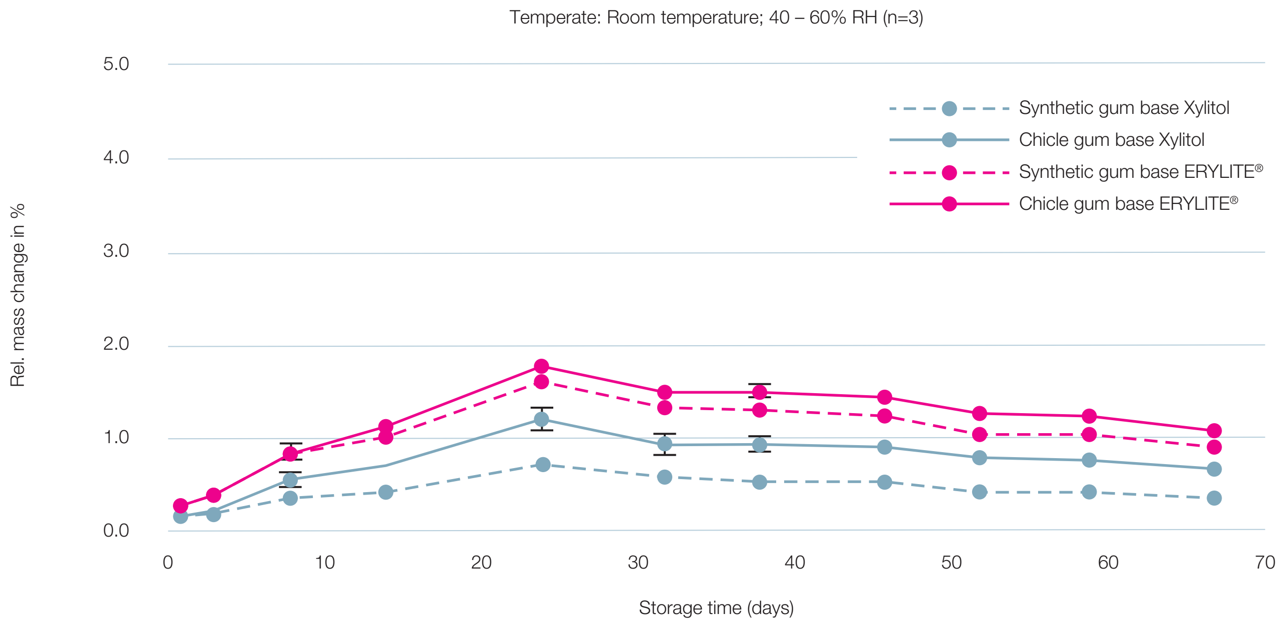

Figure 1: Relative mass change of chewing gum with synthetic or natural chicle gum base, sweetened with xylitol or ERYLITE® and stored under temperate conditions

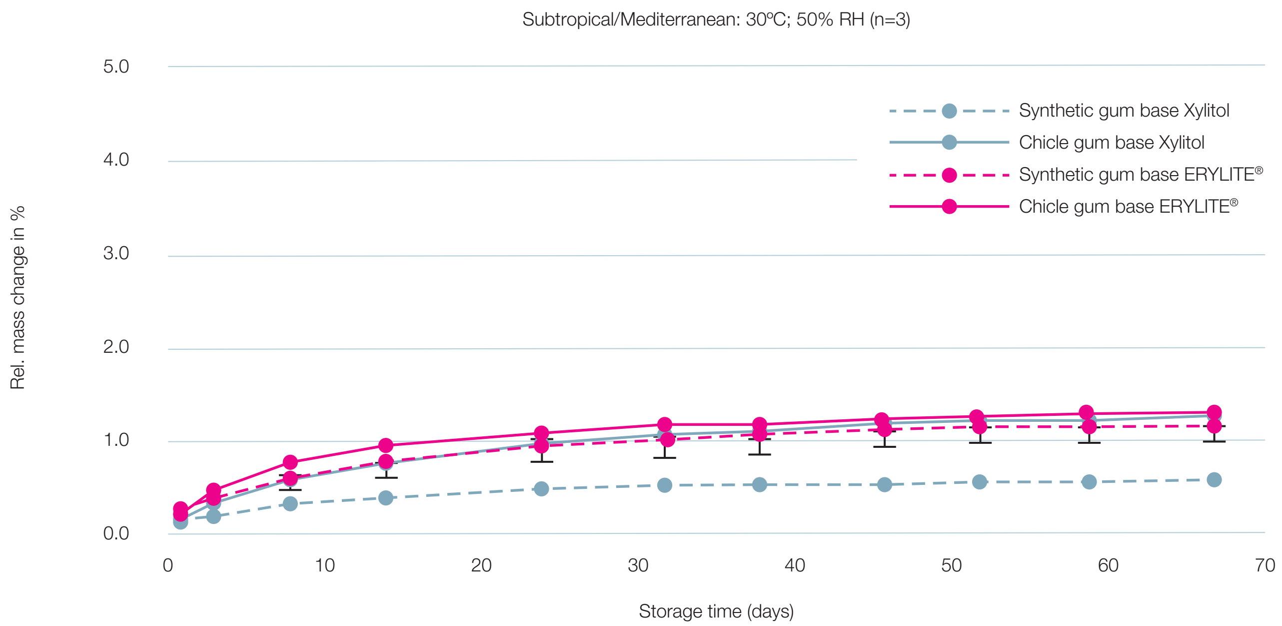

Figure 2: Relative mass change of chewing gum with synthetic or natural chicle gum base, sweetened with xylitol or ERYLITE® and stored under subtropical/Mediterranean conditions

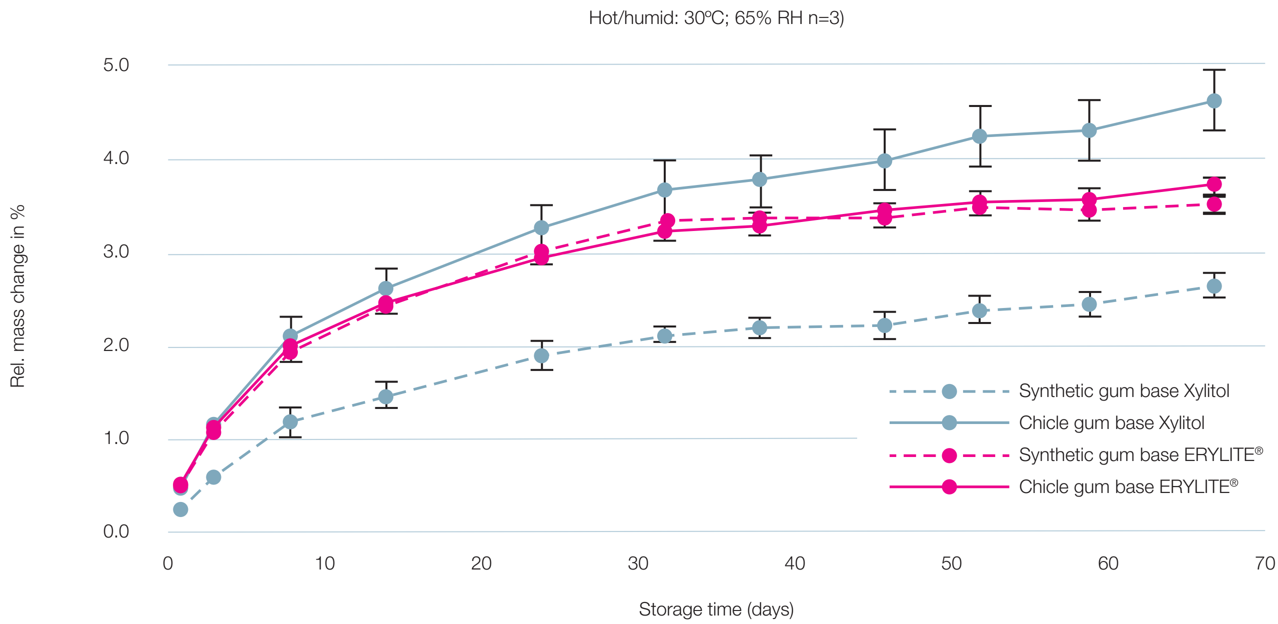

Figure 3: Relative mass change of chewing gum with synthetic or natural chicle gum base, sweetened with xylitol or ERYLITE® and stored under hot/humid conditions

According to the literature, xylitol is highly hygroscopic while erythritol is not hygroscopic as compared to sugar or other sugar alcohols.[8] Nevertheless, the storage tests showed both recipes to be relatively stable at room temperature and under Mediterranean storage conditions. Interestingly, while small differences were observed between the synthetic and the chicle gum base with xylitol under hot/humid conditions, the samples with ERYLITE® exhibited similar behaviour regardless of which gum base was used.

Texture analysis

The following figure 4 shows that the force required to break the chewing gums is similar regardless of whether they contain ERYLITE® or xylitol. Although the synthetic gum containing xylitol appeared to be more resistant to extension, this was not statistically significant and ERYLITE® and xylitol are comparable in this respect.

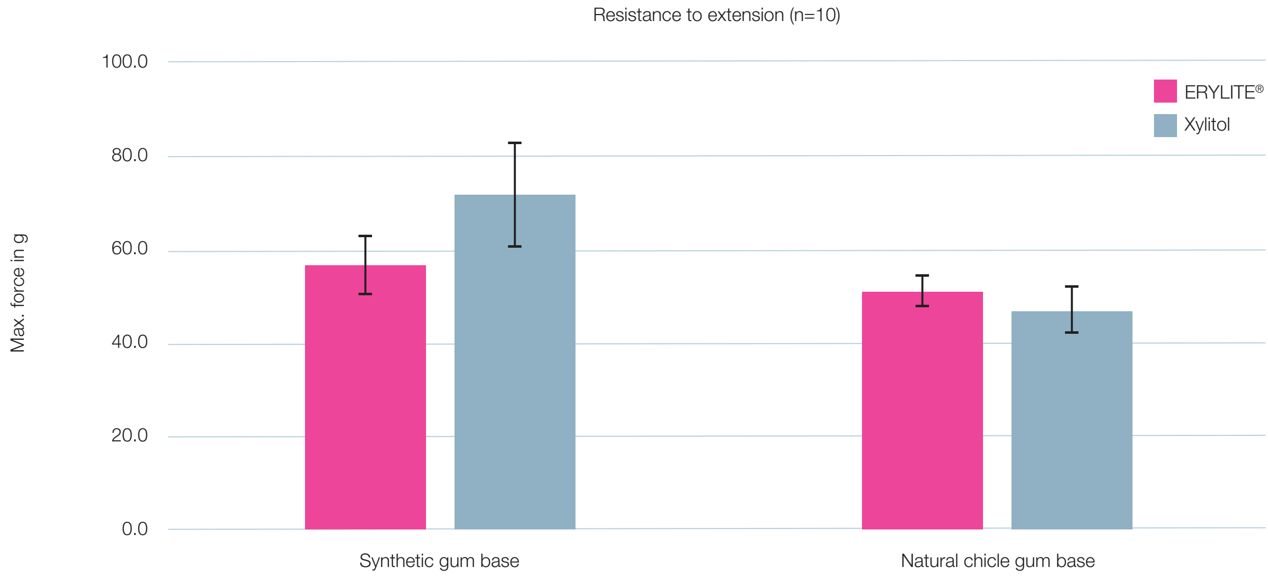

Figure 4: Resistance to extension of chewing gum with synthetic or natural chicle gum base, sweetened with xylitol or ERYLITE®

The extensibility (figure 5), i.e. the distance until the chewing gums break, is the same for ERYLITE® and xylitol, in combination with both the synthetic gum base and the natural chicle gum base.

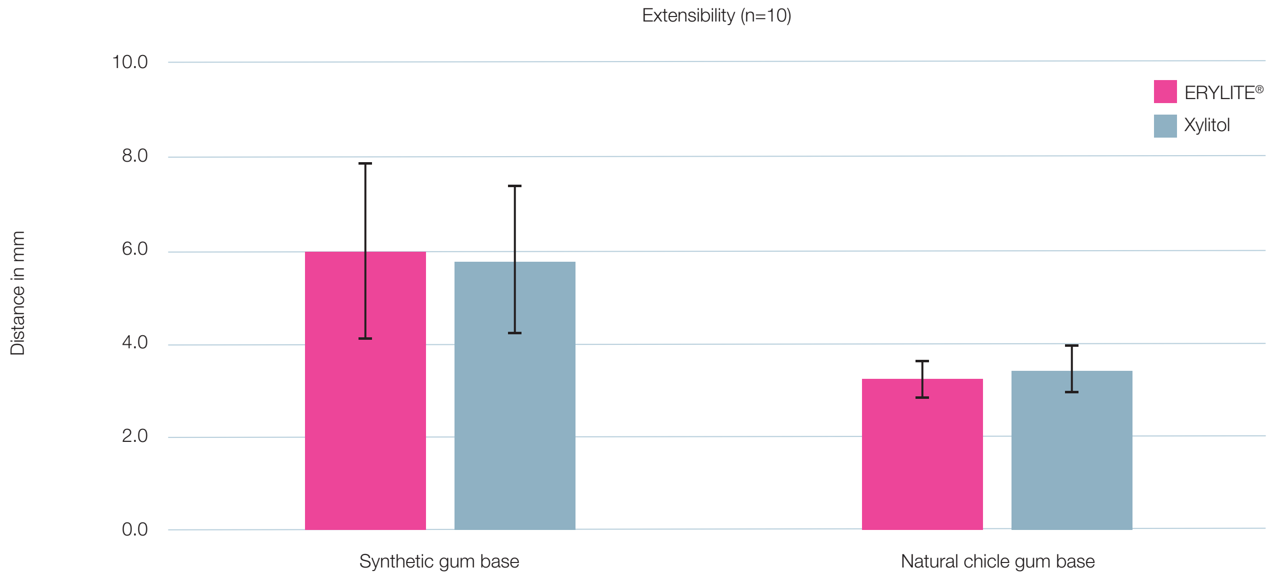

Figure 5: Extensibility of chewing gum with synthetic or natural chicle gum base, sweetened with xylitol or ERYLITE®

The texture analysis represents an attempt to illustrate the effects of ERYLITE® and xylitol on texture based on quantitative data. Although the method might miss some physiological aspects like the influence of saliva, it provides a good indication that adding ERYLITE® or xylitol will lead to similar effects in each case.

Sensory evaluation
For the “just-about-right” analysis, each product was evaluated in a separate session on different days and so there was no direct comparison in this set-up. The following graphs show the results expressed as frequencies of each attribute for synthetic chewing gum with ERYLITE® or xylitol as well as chicle gum with ERYLITE® or xylitol.

Both sensory evaluations with chewing gum using the synthetic gum base (figure 6) indicate that the texture of the chewing gum was perceived as too hard, both initially and after 120 seconds of chewing. The initial sweetness was mostly rated “just right” but overall sweetness intensity decreased while chewing. This was especially the case for chewing gums with ERYLITE®. The flavour was not intense enough in either product. The cooling sensation was perceived as “just right” by 62% (ERYLITE®) and 68% (xylitol), respectively.

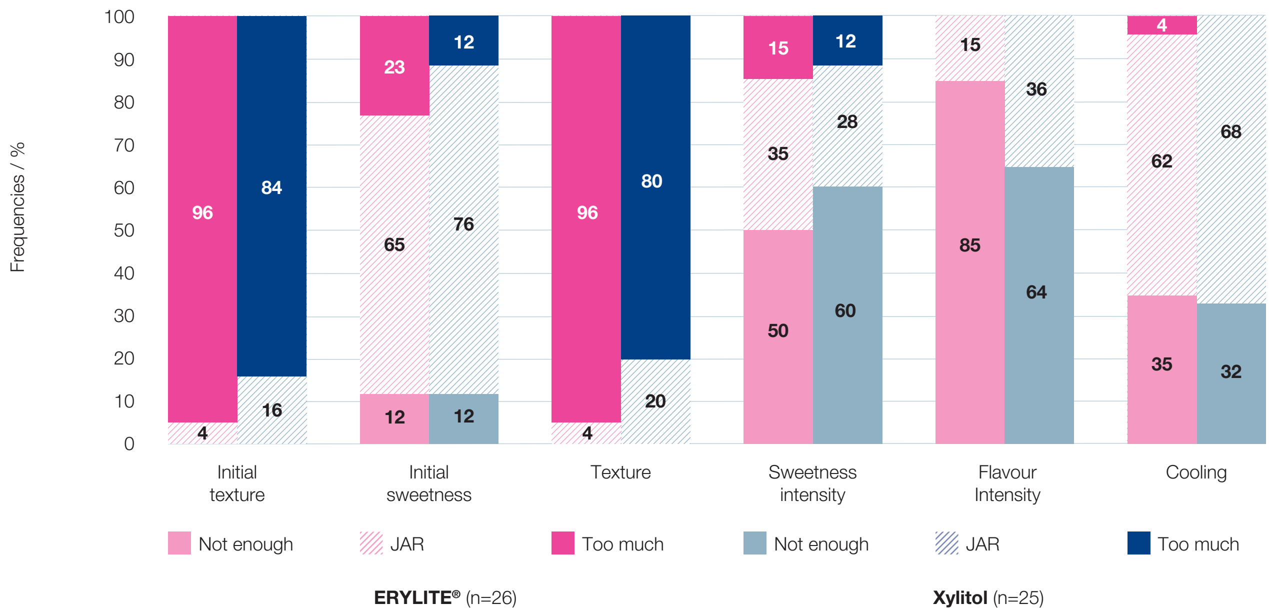

Figure 6: Results of "just-about-right" alalysis of synthetic gums with ERYLITE® and xylitol

Irrespective of whether ERYLITE® or xylitol was used, both chewing gums with the chicle gum base (figure 7) were perceived as too hard at the initial stage. However, the chicle gum versions were rated as less hard compared to the synthetic gum base.

The initial and overall sweetness of xylitol seems to be higher ("just right") compared to ERYLITE® (initial sweetness vs. sweetness intensity).

Flavour expression was too low in both chicle-based chewing gums. The cooling sensation was pleasant and with ERYLITE® even more acceptable (65% "just right") than with xylitol (50% "just right").

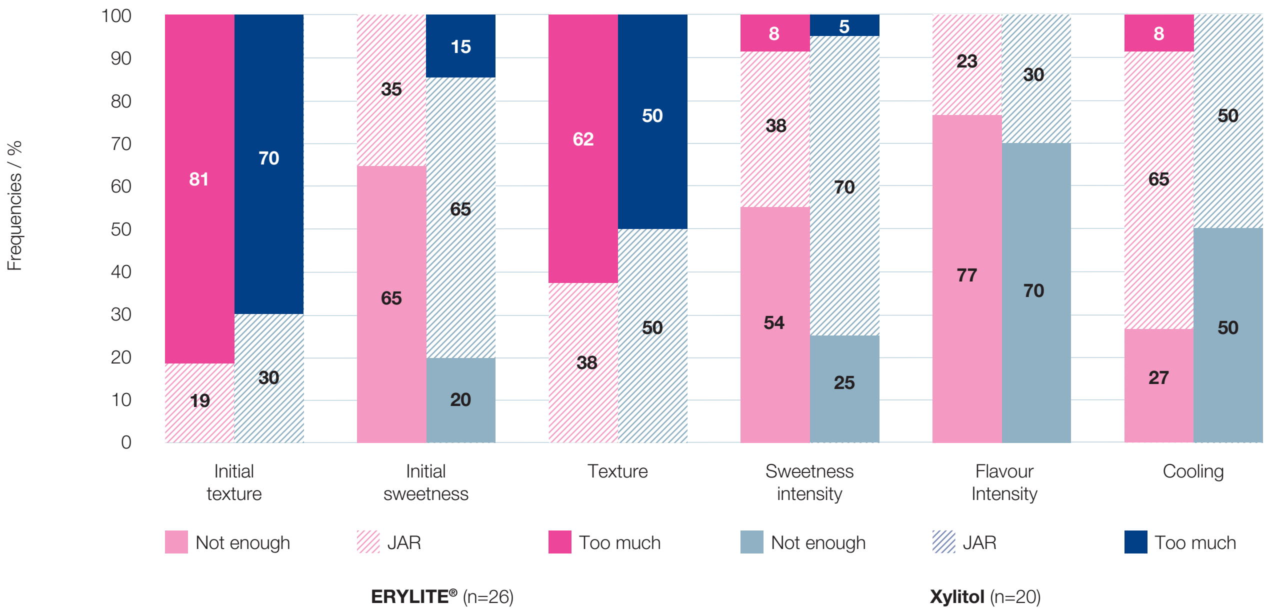

Figure 7: Results of "just-about-right" alalysis of natural chicle gums with ERYLITE® and xylitol

Detection of potential differences between the two sweetening systems was enhanced by comparing both versions of synthetic gum and natural chicle gum directly through paired comparison tests for attributes of specific interest (sweetness, hardness and cooling sensation) as shown in table 2.

Table 2: Results of paired comparison tests (n=19, sign. level α=0.05)

Paired comparison tests	Sweetness	Hardness	Cooling effect
Synthetic gum base: ERYLITE® vs. xylitol	No sign. difference (p-value: 0.3593)	No sign. difference (p-value: 0.0636)	Sign. difference (p-value: 0.0192)
Natural gum base: ERYLITE® vs. xylitol	Sign. difference (p-value: 0.0192)	No sign. difference (p-value: >0.9999)	No sign. difference (p-value: 0.3593)

There was no significant difference between the synthetic chewing gum with ERYLITE® or xylitol in terms of sweetness or hardness. This corroborates the findings of the "just-about-right" evaluation where both synthetic gums were perceived as too hard and overall sweetness values were low. In this direct comparison, the cooling effect was perceived as significantly stronger for the xylitol version.

The chewing gums based on chicle did not differ significantly in terms of hardness or cooling effect, but here xylitol was perceived as significantly sweeter than ERYLITE®, which can be also seen in the results of the "just-about-right" analysis (initial and sweetness intensity).

The results of the paired comparison tests complement the findings of the "just-about-right" evaluation and reveal that, in general, there may be differences between ERYLITE® and xylitol. However, no conclusions can be drawn from this study regarding the extent to which these differences are due to the inherent properties of the sweetener or the overall recipe (influence of gum bases or other ingredients).

During the sensory evaluation, some of the panellists were critical of the hardness of the gum during chewing. Since this applied to both polyols, this is most likely to be due to a problem in the underlying recipe and could be resolved with appropriate modifications. A first step would be to address the milling and/or sieving of the particles. Finer sweetener particles generally increase hardness of the gum and therefore, modification of the particle size distribution would improve the texture. Alternatively, the amount or composition of the gum base could be modified using plasticisers and moisturisers. A second criticism was the sweetness, which was perceived as less pronounced in the chewing gums with ERYLITE®. Here, we suggest increasing the amount of stevia. In any case, producers will develop a recipe that provides their desired final texture, flavour and sweetness intensity.

Finally, an informal sensory screening comparing chewing gums with and without zinc salts indicated that Jungbunzlauer zinc salts do not seem to have a negative impact on taste. However, since these results were obtained only with a small test panel and the addition of only 15% NRV in 100 g of chewing gum, further experiments and testing are recommended.

Regulatory

Both erythritol and xylitol are Group IV polyols. They can be used quantum satis in chewing gums provided that the product recipe contains no added sugar (Commission Regulation (EU) No 1129/2011). In the US, erythritol and xylitol both can be used up to 75% in chewing gum.

We would also suggest conducting a careful evaluation of local regulatory restrictions of mineral fortification in sweets. This is generally allowed in Europe, but restricted by the FDA.

Summary

In conclusion, our results show that ERYLITE® can be used as a sweetener in chewing gums and offers a natural alternative to other commonly used sweeteners. Results for recipes with ERYLITE® were very similar to those with xylitol in terms of storage stability and texture analysis. Some differences that were detected during the sensory evaluation can be addressed easily by making adjustments to the recipe.

Acknowledgements

We are grateful to Mr Geschwindner and the Zentralfachschule der Deutschen Süßwarenwirtschaft, Solingen for sharing their expertise and providing raw materials..

References

[1] Allen AP, Smith AP. Chewing Gum: Cognitive Performance, Mood, Well-Being, and Associated Physiology. Biomed Res Int 2015:654806

[2] McGowan BA, Padua GW, Lee S-Y. Formulation of corn zein chewing gum and evaluation of sensory properties by the time-intensity method. J Food Sci 2005;70:475–481

[3] Sostmann K, Lochem R van, Roos K de. The influence of gum base composition on flavour release from chewing gum. In: Flavour Research at the Dawn of the Twenty-first Century – Proceedings of the 10th Weurman Flavour Research Symposium, Beaune, France, 25-28 June 2002. Eds. Le Ouéré JL, Étiévant PX. Paris, France 2003 pp. 252-255 ref 6.

[4] Raithore S, Peterson DG. Effects of polyol type and particle size on flavor release in chewing gum. Food Chem 2018;253:293–299

[5] Tisdale E, Wilkins C. Method development for compositional analysis of low molecular weight poly(vinyl acetate) by matrix-assisted/laser desorption-mass spectrometry and its application to analysis of chewing gum. Anal Chim Acta 2014;820:92–103.

[6] Article in The Sunday Times: Chewing-gum firms' sticky dilemma: clean up the pavements or pay more tax. March 28 2021

[7] Stable Micro Systems. How to Measure Extensibility/Elongation. https://www.stablemicrosystems.com/MeasureExtensibility.html, accessed 10 February 2022, 16:50

[8] Mitchell H. Sweeteners and Sugar Alternatives in Food Technology. Oxford:Wiley-Blackwell, 2006

About Jungbunzlauer

Jungbunzlauer is one of the world's leading producers of biodegradable ingredients of natural origin. We enable our customers to manufacture healthier, safer, tastier and more sustainable products. Thanks to continuous investment, state-of-the-art manufacturing processes and comprehensive quality management, we are able to provide outstanding product quality.

Our mission "From nature to ingredients®" commits us to protecting people and their environment.

The Authors

Dr Marianne Dölz – Technical Service, Jungbunzlauer International AG
marianne.doelz@jungbunzlauer.com

Florian Gutschalk – Application Technology, Jungbunzlauer Ladenburg GmbH
florian.gutschalk@jungbunzlauer.com

Johanna Guse – Application Technology, Jungbunzlauer Ladenburg GmbH
johanna.guse@jungbunzlauer.com

Discover more on
www.jungbunzlauer.com