

# Bridging the gap between tradition and sustainability

Imagine a world without preservatives. Shampoo would be packaged in single-use packets. Face cream would be stored in the refrigerator and disposed of after about a week. No personal care products would last without special care and wasteful packaging – it would all be a bit inconvenient and expensive.

Modern personal care products contain protein, vitamins and natural materials, just like food products. Most people would never expect an opened container of mayonnaise to stay fresh stored in the

bathroom for months. Yet we expect this of our personal care products. The use of effective preservatives is what allows our personal care products to remain safe for use under typical storage and use conditions.

As more traditional preservatives come under public discussion, the personal care industry finds itself looking to alternative methodologies to preserve products. The industry has turned to the use of more natural, 'greener' alternatives. Unfortunately, these materials often have

colour, odour or incompatibility problems that make them difficult to formulate with. Combining natural, nature-identical and synthetics known to be safe and gentle can help bridge the gap between the desire for safety, sustainability and superior functionality.

## Multifunctional additives

The use of multifunctional additives is growing. These materials frequently help maintain the microbiological integrity of products as a secondary function. Often

**Table 1: schülke KoKo challenge test results with sensiva PA 30 in practical formulations.**

	Inoculation Cycles							Assessment
	0	1	2	3	4	5	6	
<b>Carbomer Gel</b> without antimicrobial stabilisation	–	+++ B,Y,M	+++ B,Y,M	./.				Failed
+1.0% sensiva PA 30	–	–	–	–	–	–	–	A
+0.5% Zemea Propanediol	–	+++ B,Y,M	+++ B,Y,M	./.				Failed
+0.35% Phenetyl Alcohol	–	+++ B,Y,M	+++ B,Y,M	./.				Failed
+0.15% Undecyl Alcohol	–	+++ B,Y,M	+++ B,Y,M	./.				Failed
<b>3-in-1 Lotion (O/W)</b> without antimicrobial stabilisation	–	+++ B,Y,M	+++ B,Y,M	./.				Failed
+1.0% sensiva PA 30	–	–	++ B,M	++ B,M	++ B,Y,M	./.		Failed
+1.5% sensiva PA 30	–	–	–	–	–	–	–	A
<b>Simply Body Cream (O/W)</b> without antimicrobial stabilisation	–	+++ M	+++ B,M	./.				Failed
+1.5% sensiva PA 30	–	–	–	++ M	+++ B,M	+++ B,M	./.	Failed
+2.0% sensiva PA 30	–	–	–	–	–	–	+ Y,M	B
<b>Rinse-off formulation with 8% sodium laureth sulfate</b> without antimicrobial stabilisation	–	+++ B,Y,M	+++ B,Y,M	./.				Failed
+1.5% sensiva PA 30	–	–	+++ B	+++ B	./.			Failed
+2.0% sensiva PA 30	–	–	–	–	–	–	–	A

**Legend:** 0 Sterility control; B Bacteria; Y Yeast; M Mould

– Free of microbial growth; + Slight growth; ++ Moderate growth; +++ Massive growth; ./.. Test cancelled due to massive growth

Assessment: A Free of growth during six inoculation cycles; B Slight growth during six inoculation cycles

their primary function is as a fragrance or humectant. Various glycols and aromatic alcohols have been used as multifunctional additives. Typically, these materials are used in combination with other multifunctional additives or as boosters for more traditional preservative actives.

Zemea propanediol, from DuPont Tate & Lyle Bio Products, is naturally-derived from fermentation of corn glucose. This natural, preservative-boosting humectant is used in a wide range of personal care products and ingredients for its multifunctional benefits. One important benefit is its antimicrobial efficacy. CTFA challenge tests have shown that Zemea can boost the efficacy of several different preservative systems (phenoxyethanol-based and natural preservatives) against various bacteria, yeasts and mould in a lotion formulation, potentially reducing the amount of preservative needed by 50% with the addition of 2-6 weight % Zemea. This benefit makes it an attractive component of finished product formulations, preservative systems and antimicrobial stabilisers. Zemea is approved by Ecocert as an ingredient of natural origin and is certified natural by the Natural Products Association.

Two new multifunctional additive blends containing Zemea propanediol have been developed by Schülke & Mayr GmbH.



Agar plate with bacteria colonies.

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These have been tested for their ability to stabilise cosmetic preparations against microbial contamination. sensiva PA 30 combines Zemea propanediol with two nature-identical fragrance ingredients for broad spectrum antimicrobial activity. Taking this concept one step further, sensiva PA 40 combines Zemea propanediol with a nature-identical fragrance ingredient and a gentle synthetic known for its moisturising properties. This combination allows sensiva PA 40 to be used at levels similar to more traditional preservative blends.

**Nature identical**

Nature identical materials are synthetically produced versions of chemistries found in nature. They are structurally and functionally identical to their naturally-occurring counterparts. However, since they are derived from synthetic sources, they offer several benefits over their natural counterparts. Synthetic materials are often more readily available. They are not subject to the vagaries of climate and growth cycles. They are typically much less expensive than natural. Synthetics can also be much more easily standardised.

**Table 2: schülke KoKo challenge test results showing boosting effects with sensiva PA 30 in practical formulations.**

	Inoculation Cycles							Assessment
	0	1	2	3	4	5	6	
<b>Alternative O/W Cream</b> without antimicrobial stabilisation	-	+++ B,Y,M	+++ B,Y,M	./.				Failed
+1.0% sensiva PA 30	-	+++ B,Y,M	+++ B,Y,M	./.				Failed
+1.5% sensiva PA 30	-	-	-	-	-	-	-	A
+1.0% sensiva PA 30 +0.1% euxyl K 712	-	-	-	-	-	-	-	A
<b>Alternative W/O Cream</b> without antimicrobial stabilisation	-	++ B,Y,M	++ B,Y,M	+++ B,Y,M	+++ B,Y,M	./.		Failed
+1.0% sensiva PA 30	-	+ B,M	++ B,M	++ B,M	++ B,M	++ B,M	++ B,M	Failed
+1.5% sensiva PA 30	-	-	-	+ B	+ B	+ B	+ B	B
+2.0% sensiva PA 30	-	-	-					A
+1.0% sensiva PA 30 +0.1% sensiva SC 50	-	-	-					A
<b>Natural O/W Cream</b> without antimicrobial stabilisation	-	+++ B,Y,M	+++ B,Y,M	./.				Failed
+2.0% sensiva PA 30	-	+++ B,Y,M	+++ B,Y,M	./.				Failed
+2.0% sensiva PA 30 +0.05% active matter of Dissolvine GL 47 S	-	-	-	-	-	-	-	A

**Legend:** As in Figure 1

Table 3: schülke KoKo challenge test results with sensiva PA 40 in practical formulations.

	Inoculation Cycles							Assessment
	0	1	2	3	4	5	6	
<b>Alternative o/w Cream</b> without antimicrobial stabilisation	–	+++ B,Y,M	+++ B,Y,M	./.				Failed
+0.75% sensiva PA 40	–	–	–	–	–	–	–	A
+0.34% Phenylpropanol	–	++ B,Y,M	++ B,Y,M	++ Y,M	++ B,Y,M	++ B,Y,M	++ B,Y,M	Failed
+0.22% Zemea Propanediol	–	+++ B,Y,M	+++ B,Y,M	./.				Failed
+0.19% Caprylyl Glycol	–	+++ B,Y,M	+++ B,Y,M	./.				Failed
<b>Body Lotion (O/W)</b> without antimicrobial stabilisation	–	+++ B,Y,M	+++ B,Y,M	./.				Failed
+1.0% sensiva PA 40	–	+++ M	+++ M	./.				Failed
+1.25% sensiva PA 40	–	–	–	–	–	–	–	A
<b>W/O Cream</b> without antimicrobial stabilisation	–	+++ M	+++ B,M	./.				Failed
+0.5% sensiva PA 40	–	+ B,Y	+ B,Y,M	+ B	+ B	+ B	–	B
+0.75% sensiva PA 40	–	–	–	–	–	–	–	A
<b>Natural O/W Wellness Body Lotion</b> without antimicrobial stabilisation	–	+++ B,Y,M	+++ B,Y,M	./.				Failed
+0.75% sensiva PA 40	–	+++ B,M	+++ B,M	./.				Failed
+1.0% sensiva PA 40	–	–	–	–	–	–	–	A
<b>High SPF Inorganic Sunscreen</b> without antimicrobial stabilisation	–	++ B,Y,M	++ B,Y,M	++ B,Y,M	++ B,Y,M	++ B,Y,M	+++ B,Y,M	Failed
+1.0% sensiva PA 40	–	+ M	+ B	+ B	+ M	+ M	+ M	B
+1.5% sensiva PA 40	–	–	–	–	–	–	–	A

Legend: As in Figure 1

Colour, odour and activity are more likely to be consistent batch to batch. This is particularly important for preservatives. Slight variations in preservative activity can mean the difference between an adequately preserved product and a product recall.

## Methods and test material

### Challenge tests

In the schülke KoKo in-house test a mixture of bacteria, yeasts and mould are inoculated six times (once a week) into the test material, with the goal of keeping the test material germ-free for this period. The inoculum contains pathogenic microorganisms, as well as germs which are well-known for product spoilage. All species are cultivated separately and mixed directly before the addition to ensure a constant composition and germ count of the inoculum. The total germ count is approx.  $10^{7-8}$  cfu/mL, which equates to

approximately  $10^5$  cfu/mL of each organism in the sample. Nutrient media are TSA (tryptone-soya-agar) for bacteria and SA (sabouraud-dextrose-agar) for yeasts and mould.<sup>1</sup>

The schülke KoKo Test is specifically validated for the assessment of cosmetic products. From many years of experience<sup>2,3</sup> these results have been shown to equate to a microbiological stability of 30 months, as recommended for cosmetic products. Test criteria A is fulfilled if the product remains free from contamination after each of the six inoculation cycles. Test criteria B is fulfilled if the sample shows no more than slight microbial growth (+) during any or all of the six inoculation cycles. If the formulation meets criteria B, a microbial risk analysis should demonstrate the existence of control factors not related to the formulation, for example a protective package and/or following

strict Good Manufacturing Practice (GMP), before the product is considered safe for consumer use.

### Preparation of inoculum

For the production of an inoculum, microorganisms are washed off from the nutrient media plates and adjusted to the required starting germ count by dilution. For the schülke KoKo test, the single cultivated microorganisms are brought together into a mixed suspension. To guarantee a constant composition of the mixed inoculum, the mixed suspension is stored for a maximum of three days in a refrigerator. A new inoculation suspension is prepared for each inoculation cycle.<sup>1</sup>

### Test material

All described tests have been conducted using sensiva PA 30 and sensiva PA 40. sensiva PA 30 consists of the nature

Table 4: schülke KoKo challenge test results showing boosting effects with sensiva PA 40 in practical formulations.

	Inoculation Cycles							Assessment
	0	1	2	3	4	5	6	
<b>Alternative O/W Cream</b> without antimicrobial stabilisation	–	+++ B,Y,M	+++ B,Y,M	./.				Failed
+0.5% sensiva PA 40	–	–	–	–	+ B	+ B,M	+ B,M	B
+0.7% sensiva PA 40	–	–	–	–	–	–	–	A
+0.3% sensiva PA 40 + 0.4% euxyl PE 9010	–	–	–	–	–	–	–	A
pH 5.5 +0.3% sensiva PA 40 +0.3% euxyl K 702	–	–	–	–	–	–	–	A
<b>Pure Natural Care Wet Wipe</b> without antimicrobial stabilisation	–	+++ B,Y,M	+++ B,Y,M	./.				Failed
+0.7% sensiva PA 40	–	++ B,M	++ B,M	+++ B,M	./.			Failed
pH 5.5 +0.5% sensiva PA 40 + 0.5% euxyl K 712	–	–	–	–	–	–	–	A
<b>High SPF Inorganic Sunscreen</b> without antimicrobial stabilisation	–	++ B,Y,M	++ B,Y,M	++ B,Y,M	++ B,Y,M	++ B,Y,M	+++ B,Y,M	Failed
+1.0% sensiva PA 40	–	+ M	+ B	+ B	+ M	+ M	+ M	B
+0.7% sensiva PA 40 +0.2% active matter of Dissolvine GL 47 S	–	–	–	–	–	–	–	A

**Legend:** As in Figure 1

identical ingredients phenethyl alcohol and undecyl alcohol and the natural moisturiser Zemea Propanediol, derived from corn. PA 40 includes nature identical phenylpropanol, caprylyl glycol and Zemea Propanediol. Both products are stabilised with the antioxidant tocopherol. For the boosting tests, sensiva SC 50 (ethylhexylglycerin), euxyl PE 9010 (ethylhexylglycerin, phenoxyethanol), euxyl K 702 (phenoxyethanol, benzoic acid, dehydroacetic acid, aqua, ethylhexylglycerin, polyaminopropyl biguanide), and euxyl K 712 (aqua, sodium benzoate, potassium sorbate) from schülke have been used, as well as the chelating agent Dissolvine GL 47 S (tetrasodium glutamate diacetate) from AkzoNobel.

## Results

The antimicrobial activity of the two synergistic blends PA 30 and 40 has been demonstrated in schülke KoKo challenge tests. Table 1 shows the optimisation of the blend, PA 30, in a carbomer gel. One per cent of PA 30 stabilises the formulation sufficiently, whereas the single ingredients have no effect on the microbial growth. Additionally, different practical formulations have been tested. PA 30 stabilises the formulations well at levels between 1.0% and 2.0%, including a rinse-off formulation with 8% sodium laureth sulfate. A criteria B

is achieved with 2.0% PA 30 for the difficult-to-preserve formulation 'Simply Body Cream' (Table 1).

PA 30 acts as a booster in combination with soft preservatives. Combined with small amounts of the well-known booster, ethylhexylglycerin, or chelating agents its antimicrobial activity is enhanced (Table 2).

PA 40 is highly efficient in even lower concentrations. The test results in Table 3 show that 0.75% of PA 40 is enough to stabilise an oil-in-water cream. Looking at the single ingredients, there is no effect when using propanediol and caprylyl glycol alone, and only a minor effect by the fragrance ingredient phenylpropanol. Further results of PA 40 in practical formulations show its efficacy between 0.5% and 1.5%, including a sunscreen formulation containing high concentrations of zinc oxide and titanium dioxide (Table 3).

PA 40 also provides synergistic effects combined with soft preservatives like euxyl PE 9010 or blends based on organic acids. The addition of a chelating agent increases the antimicrobial efficacy (Table 4).

## Conclusion

Public discussion of many traditional preservative chemistries has made it more difficult for formulators to develop adequately preserved products. Inadequately preserved personal care

products are a public health risk that can trigger a product recall and severely damage the reputation of the manufacturer. As a result, many formulators are turning to natural and nature-identical multifunctional additives as a way to maintain the microbiological stability and safety of their products.

Schülke & Mayr GmbH has a long history of combining chemistries to obtain optimised preservative systems. The boosting effect of naturally-derived Zemea Propanediol, from DuPont Tate & Lyle Bio Products, combined with nature-identical fragrance materials and gentle synthetics, give sensiva PA 30 and sensiva PA 40 the ability to stabilise many personal care formulations to the same stringent criteria as more traditional preservative blends, bridging the gap between tradition and sustainability. PC

## References

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