

Rambutan bioactives for hair and skin

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Abstract

BASF is sourcing the raw materials for three new highly effective natural skin and hair care ingredients from two of Vietnam's first organic-certified rambutan gardens. The bioactives are extracted from the fruit's peels, leaves and seeds – potential byproducts of fruit cultivation that are usually discarded. This form of upcycling benefits both the environment and local rural communities.

Although Dong Nai province in Southeast Vietnam is one of the country's main manufacturing hubs, its agricultural roots are also apparent: At the end of 2016, 278,000 hectares – 47.5% of the province's area – were used for agriculture.¹ The 11,000 hectares used for growing rambutan trees (*Nephelium lappaceum*) may not seem much, but they make Dong Nai the country's most important cultivation area. Consumers include those who simply love the taste of the juicy fruits, people seeking out their many health benefits, which the 'super fruits' are famed for throughout Asia, and – since BASF launched three new bioactives that protect the skin and hair against pollution, dehydration and signs of ageing earlier this year – manufacturers of personal care products.

The bioactives, which were developed based on the expertise of BASF's interdisciplinary innovation platform for extracting valuable plant substances, are obtained from byproducts of the fruit's cultivation: Nephhydrat™ (INCI: Glycerin (and) Water (and) Nephelium Lappaceum Peel Extract) from the spiny fruit peel, Nephoria™ (INCI: Maltodextrin (and) Nephelium Lappaceum Leaf Extract) from the evergreen leaves, and Rambuvital™ (INCI: Maltodextrin (and) Nephelium Lappaceum Seed Extract) from the seeds.

Sustainable sourcing

To sustainably source the raw materials, BASF created its dedicated Rambutan Program in 2015, and has worked closely with Vietnamese farmers ever since. The programme provides transparency into the supply chain, its participants and practices.

The peel, leaves and seeds come from Vietnam's first organic-certified rambutan gardens in Dong Nai. Together, the two gardens feature more than 200 rambutan trees aged 25 to 30 years old, covering an area of three hectares.

A dedicated rambutan team was established in 2017 for a pilot harvest and to process the various parts of the plant. They maintain the gardens throughout the year and then harvest the fruit between July and September: sorting leaves and fruits, removing the peel, and separating pulp and seed. BASF benefits from their expertise. At the same time, the programme provides the team with a steady, above-average income, health insurance, free meals and safe working conditions. With good care, rambutan trees can live for up to a hundred years, providing the local rural communities with a reliable income stream for years to come.

Peel extract strengthens and hydrates the skin

Nephhydrat is a natural extract of rambutan pericarps (the fruit's spiny peel), standardised in polyphenols. The preservative-free liquid is incorporated during final processing at a recommended concentration of 2% and at a temperature of below 30°C.

In vitro, the bioactive has been proven to strengthen the outermost layer of the epidermis – the stratum corneum – by stimulating phospholipids and ceramides, involucrin, hornerin, and transglutaminase-1. Figure 1 shows lipid variations versus an untreated control. The bioactive significantly increased phospholipid

synthesis, which is the first step in the biosynthesis of the fatty acid components of the lipidic cement, by 15%. Total ceramides, including the long-chain ceramides that are essential in lipid organisation and barrier function,² increased respectively by 20% and 12%.

The peel extract also optimises cell energy by increasing ATP production, protects mitochondria against dehydration and stress, and increases the intracellular taurine content to lock moisture within skin cells.³

The *in vivo* effect on skin hydration was tested in a double-blind, randomised, hemi-face, placebo-controlled clinical study featuring 27 Caucasian female volunteers aged 29 to 46 with dry facial skin. Figure 2 shows the improvement in skin hydration after starting treatment with a placebo formulation and a formulation containing the peel extract at 2%. After 28 days of twice-daily application, hydration increased significantly by 7% vs. baseline ($p < 0.001$). The placebo formulation also showed an improvement in hydration vs. baseline, but this increase was not significant. The bioactive demonstrates better performance than the placebo, but the difference between the two products is not statistically significant.

In independent self-assessment studies conducted in Europe, Asia and North-America, consumers in each region using 2% peel extract formulations confirmed the benefits for their skin after two weeks, with an improvement in skin hydration seen by 94% of European participants, and improvements in skin softness and radiance for 90% and 83% of North American participants, respectively.

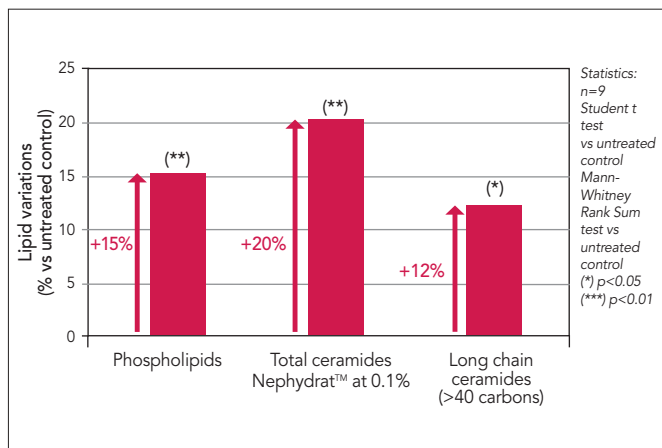


Figure 1: The effect of Nephhydrat on lipid synthesis.

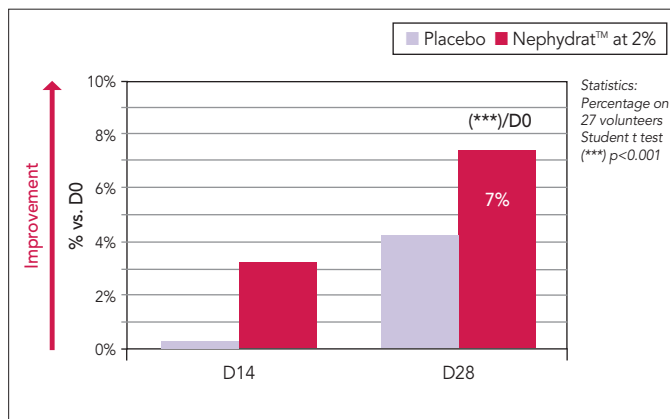


Figure 2: Percentage of skin hydration improvement vs. baseline, measured with MoistureMap equipment.

Leaf extract rejuvenates the skin, improves elasticity and reduces crow's feet

Rich in corilagin, the rambutan leaf has been used to create a rejuvenating active ingredient where the precious molecule is concentrated by a factor of 15. The titrated natural extract of rambutan leaves, Nephoria, is distributed as a preservative-free powder, dissolved at 20% weight-for-weight in water at room temperature, and then incorporated at a temperature of between 15 and 30°C during final processing. The recommended concentration is 0.1%.

In vitro, the leaf extract boosts the major dermal structural protein collagen I and the prolyl 4-hydroxylase, playing a central role in the formation and stabilisation of its triple helical structure.⁴ Figure 3 illustrates the extract's effect on the protein expression of collagen I: It significantly increases protein synthesis in a dose-dependent manner by up to 63% at 0.06%.

Furthermore, the bioactive inhibits CCN1 synthesis, a down-regulator of collagen homeostasis.⁵ On 3D bioprinted skin, the bioactive's efficacy was confirmed

as it improved the density of the extracellular collagen fibres, leading to a denser dermis. Additionally, the leaf extract stimulated gene expression and the protein synthesis of several players involved in elastic fibre assembly, such as Fibulin-5, MFAP4 and Emilin-1. To conclude, the leaf extract acts both on skin elasticity and firmness, just as the gold-standard active retinol does.

In a double-blind, randomised, split-face, placebo-controlled clinical study featuring 28 women with fair white to light brown skin (Fitzpatrick scale phototype 1-3) and aged 55 to 65, BASF evaluated the ability of the leaf extract to improve the major signs of ageing. The volunteers showed grade 3 to 4 crow's feet wrinkles according to the Bazin Atlas⁶ and considered themselves to have lost skin elasticity and firmness. They applied leaf extract at 0.1% and a placebo formulation twice a day for a period of 28 days. The measurements were taken at D0 and D28.

Figure 4 shows that application over 28 days significantly improves immediate elasticity and elasticity recovery parameters compared to baseline. Changes are greater

than those obtained with the placebo, although this difference is not statistically significant.

The before/after pictures show a significant reduction in the maximum and mean depth of crow's feet wrinkles, as well as crow's feet area roughness.

Seed extract protects hair from pollution and reinforces the scalp's skin barrier

Rambuvital is a natural extract of rambutan seeds, titrated in Kaempferol diglycoside. The preservative-free powder is dissolved at 20% weight-for-weight in water at room temperature and then incorporated at between 15 and 30°C during final processing. The recommended concentration is 0.1%.

The seed extract helps the hair to fight the detrimental effects of pollution by inducing freshness, vitality and moisturisation. The bioactive has unique anti-odour properties, as proven by an *ex vivo* sniff test, and decreases the volatile organic compounds released by hair after exposure to exhaust gases. Moreover, it helps energise the hair bulb by increasing the ATP content of dermal papilla cells, protecting this key structure from the cytotoxicity of environmental pollutants.

In vitro, the seed extract also protects the scalp through dual action: It prevents sebum oxidation induced by city air pollution (which is responsible for scalp irritation), and helps reinforce the scalp's epidermal barrier. Figure 6 shows the stimulating effect of the seed extract on the production of Loricrin and Transglutaminase-1, which are involved in the formation of the stratum corneum: At 0.05%, production of Loricrin was four times higher, and production of Transglutaminase-1 increased by 59%.

To prove the effect of the seed extract on hair quality in rinse-off formulations, a double-blind, randomised and placebo-controlled study was conducted featuring 39 women with dry scalp, aged 18 to 68,

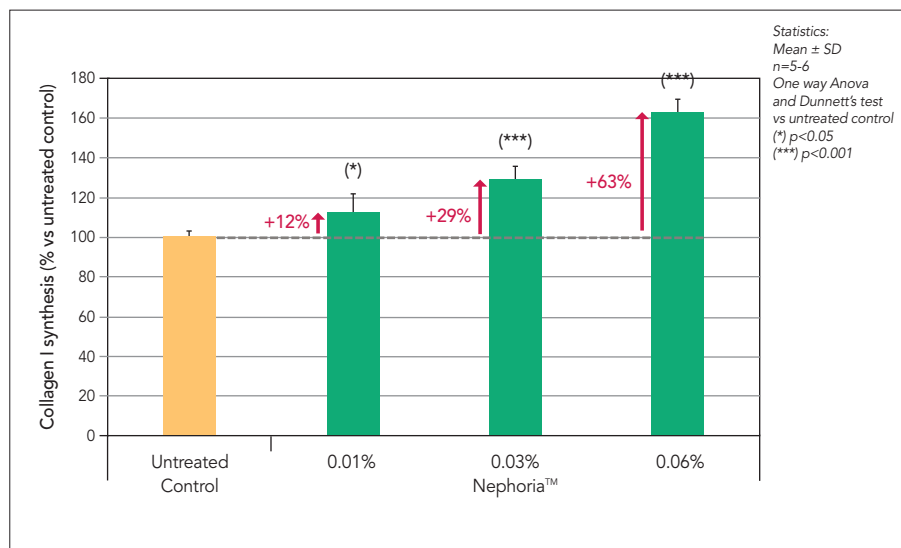


Figure 3: Effect of Nephoria on collagen I synthesis.

R5 Immediate elasticity

R7 Elasticity recovery

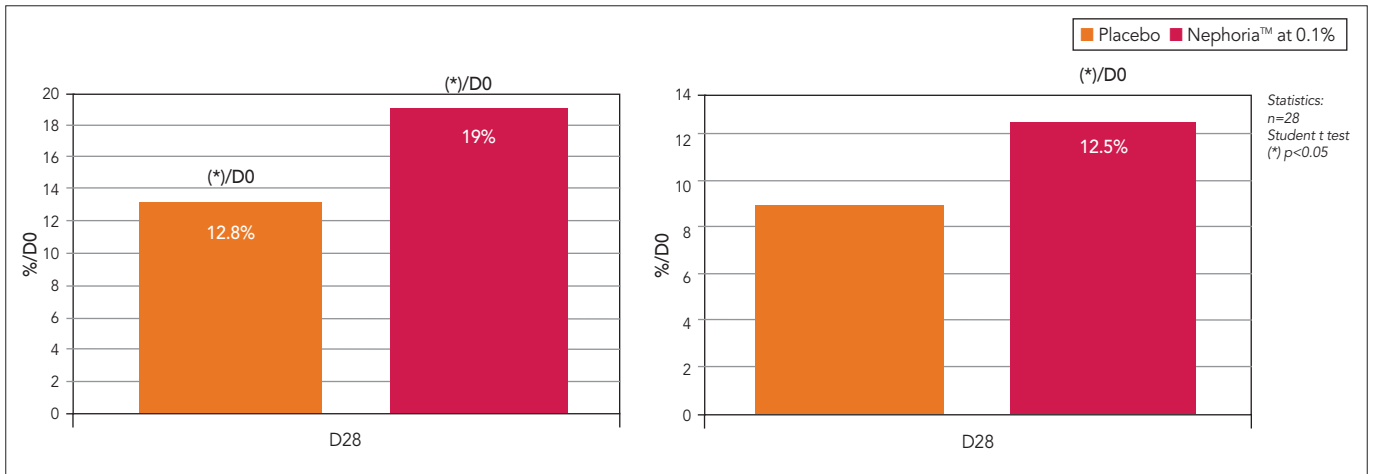


Figure 4: Percentage of change in cheek elasticity vs. baseline, measured with Cutometer.

divided in two groups. The participants applied and massaged into the entire scalp a shampoo and a conditioner containing 0.1% seed extract, or the placebo formulas, at least two to three times per week for 28 days.

Figure 7 shows consumer perception of the product's efficacy on scalp and hair, based on questionnaire responses. After 14 days, a significant majority of volunteers perceived that the seed extract shampoo and conditioner delivered perceptible healthy-looking benefits associated with an increase in hair shininess, a decrease in brittleness and an improvement in how long the hair smelled good after application (Fig 7A). These benefits were retained after 28 days (Fig 7B). Additional visual and sensorial benefits were perceived by a significant majority of volunteers and were associated with a perceived improvement in hair strength, manageability, volume, vibrancy, and time to wash.

Overall, using seed extract in rinse-off shampoos and conditioners proved to provide various benefits related to healthy-looking hair.

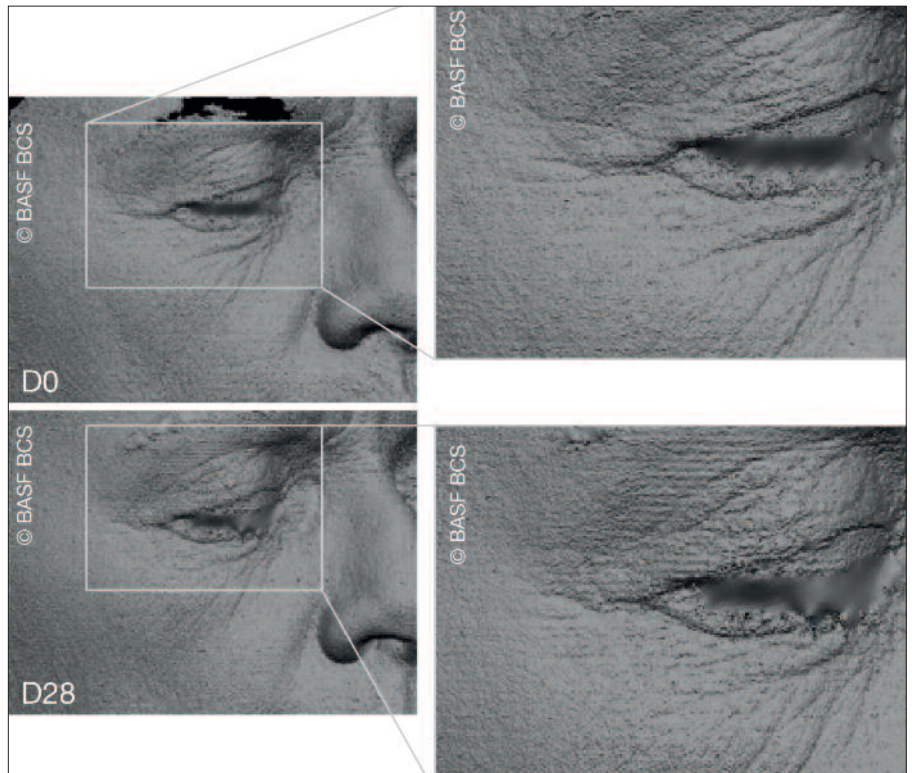


Figure 5: Nephoria visibly reduces wrinkles.

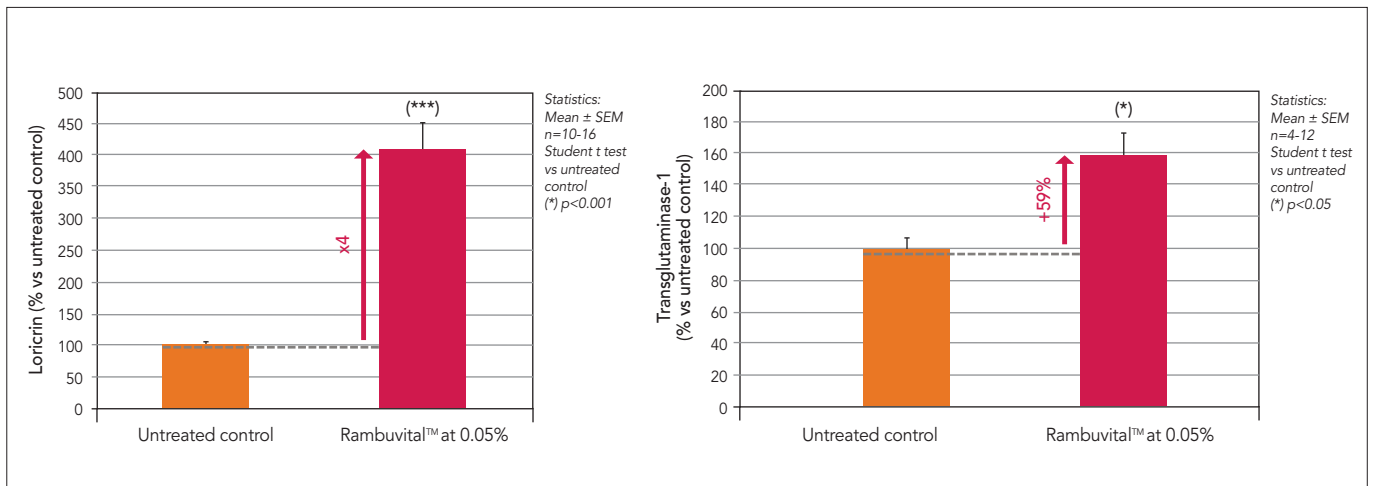


Figure 6: Effect of Rambuvital on the production of proteins constituting the cornified envelope on human keratinocytes, analysed by western blot.

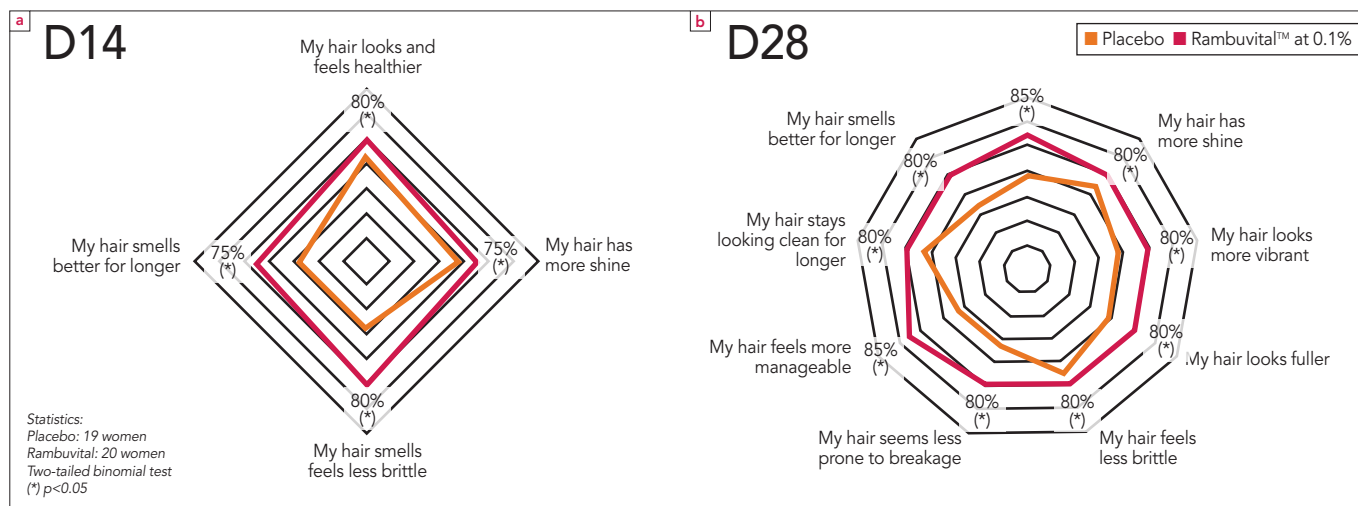


Figure 7: Volunteers' perception of hair benefits: Percentage of volunteers who agreed with the statement after 14 days of treatment (A) and after 28 days of treatment (B).

Conclusion

By tapping into the potential of rambutan byproducts, BASF is helping manufacturers satisfy the demand for responsibly sourced products: Consumers are increasingly looking for ethical solutions based on sustainable ingredients, but do not want to compromise on performance.

Nephydrat, Nephoria and Rambuvital are all preservative-free, 100% from natural origin (ISO 16128) and COSMOS-approved. The bioactives prove that it is possible to fulfil consumer demands for products that are as good for the planet as

they are for the hair and skin – and that innovation goes beyond the lab: By sourcing raw materials responsibly, BASF is making a sustainable contribution to the local communities from the rambutan gardens.

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Formulation 1: Chaq boi toi Booster

Phase	Ingredients	INCI (EU)	%wt/wt
A	Water, demin.	Aqua	52.50
	Rheocare® XGN	Xanthan Gum	0.30
	Glycerin	Glycerin	8.00
B	Eumulgin® SG	Sodium Stearoyl Glutamate	0.50
	Lanette®	O Cetearyl Alcohol	3.00
C	Consistency agent Cegesoft® HF 62	Hydrogenated Vegetable Oil	2.00
	Cetiol® MM	Myristyl Myristate	1.00
	Cetiol® RLF	Caprylyl Caprylate/ Caprate	3.00
	Cetiol® LC	Coco-Caprylate/Caprate	8.00
	Eutanol® G	Octyldodecanol	3.00
D	Veegum Pure	Magnesium Aluminum Silicate	1.50
E	Ethanol	Alcohol	5.00
	Covi-ox® T 90 EU C	Tocopherol	0.50
F	Nephoria™ BC10044	Maltodextrin, Nephelium Lappaceum Leaves Extract	0.10
	Water, demin.	Aqua	9.90
G	Sodium Benzoate	Sodium Benzoate	0.50
	Citric Acid (50% solution)	Citric Acid	1.00

Phase A: Add Rheocare XGN and glycerin into the water while stirring until a homogenous solution built up. Heat phase A and C separately to 80°C. Add phase B to phase A while stirring at 80°C. Add phase C at 80°C to phase A+B while stirring. Add phase D at 75°C to phase ABC while stirring. Homogenize with a suitable dispersion unit (e.g. Ultra Turrax) at approx. 60°C and continue with slow stirring. Add the ingredient of phase E below 40°C one after another while stirring. Add phase F while stirring. Add phase G while stirring. Adjust the pH-valve to 4.5-4.7 by adding phase H. Stop stirring at 30°C.

Formulation 2: Chom Chom Conditioner

Phase	Ingredients	INCI (EU)	%wt/wt
A	Water, demin.	Aqua	87.85
	Dehyquart® A-CA	Cetrimonium Chloride	4.00
	Sodium Benzoate	Sodium Benzoate	0.50
B	Lanette® O	Cetearyl Alcohol	3.50
	Myritol® 312 Caprylic/Capric	Triglyceride	1.00
C	Water, demin.	Aqua	3.00
	Rambuvital™ BC10059	Maltodextrin, Nephelium Lappaceum Seed Extract	0.10
	Perfume*	Parfum	0.05
E	Citric Acid (50% solution)	Citric Acid	q.s.

Heat phases A and B at 75°C. Add phase B into phase A while stirring. Allow to cool to room temperature while stirring. Solubilize Rambuvital® BC10059 in water at roomtemperature and add phase C at 30°C while stirring. Add phase D while stirring and adjust pH at 4.8 with phase E (the amount of phase E is approximate).