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Reformulation of an anti-acne skin care product line

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ABSTRACT

Acne is the most common skin condition worldwide, and at present there are no known cures, only methods of management of the disease. Skin care regimens tailored to the needs of acne-prone skin can thus prove invaluable for the management of the condition, and for the mitigation of side effects of medications used in its treatment, thereby increasing the quality of life of the user. The mechanisms involved in the pathophysiology of acne (hyperkeratosis, seborrhea, *Cutibacterium acnes* proliferation, and inflammation) should be taken into account when formulating such skin care products.

Advancements in formulation technology, new findings regarding the causes of acne and potential anti-acne active ingredients, and the ever-changing consumer preferences drive the need of the cosmetic industry to innovate and reformulate products regularly. The goal of this project was, then, to reformulate the Margarita Anti Acne line of skin care cosmetics manufactured by BLOK Laboratorija, U.A.B. (Vilnius, Lithuania). The product development timeline included ingredient research, prototype creation, volunteer testing and subsequent formulation adjustment, preliminary stability testing and preparation of the necessary documentation. The four reformulated products (a gel cleanser, an exfoliating toner, a multifunctional *gommage* and a moisturizing gel-cream) featured lactic and glycolic acids and botanical extracts (apple and willow bark). The project successfully advanced the product development process of this line, which will be commercially available in the last quarter of 2020 or first quarter of 2021.

RESUMO

A acne é a doença cutânea mais comum a nível mundial. Embora o seu impacto possa ser minimizado, atualmente desconhece-se uma cura. Por este motivo, um regime de cuidados da pele ajustado às necessidades da pele acneica é uma ferramenta valiosa na gestão deste problema cutâneo, bem como na mitigação de efeitos secundários resultantes da farmacoterapia, com vista a melhorar a qualidade de vida do utilizador. Os mecanismos patofisiológicos envolvidos na formação da acne (hiperqueratose, seborreia, proliferação de *Cutibacterium acnes* e inflamação) devem ser considerados aquando da formulação de produtos para este propósito.

O ritmo de inovação acelerado da indústria de cosméticos anti-acne deve-se a avanços contínuos na tecnologia de formulação, a descobertas sobre as causas da acne e sobre o potencial de novos ingredientes ativos, e ainda à constante necessidade de acompanhar as preferências do consumidor. Assim, o presente projeto teve como objetivo a reformulação da linha de cuidados da pele Margarita Anti Acne, produzida pela empresa BLOK Laboratorija, U.A.B. (Vilnius, Lituânia). O processo de desenvolvimento destes produtos incluiu uma pesquisa de ingredientes ativos, a criação de protótipos, testes em voluntários e subsequentes ajustes às formulações, testes de estabilidade preliminares e a preparação da documentação necessária. Os quatro produtos reformulados (um gel de limpeza facial, um tónico exfoliante, uma *gommage* multifunções e um creme-gel hidratante) contêm ácido láctico e ácido glicólico, e também extratos botânicos (de maçã e de casca de salgueiro). O projeto avançou com sucesso o desenvolvimento desta linha até às suas fases finais; os produtos estarão disponíveis no mercado no último trimestre de 2020 ou no primeiro trimestre de 2021.

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LIST OF ABBREVIATIONS AND SYMBOLS

AHA	– alpha-hydroxy acid
BDD	– body dysmorphic disorder
BHA	– beta-hydroxy acid
BPO	– benzoyl peroxide
CEO	– chief executive officer
CFU	– colony-forming unit
CPNP	– Cosmetic Product Notification Portal
CPSR	– Cosmetic Product Safety Report
EU	– European Union
FDA	– Food and Drug Administration
IGF-1	– insulin-like growth factor 1
INCI	– International Nomenclature of Cosmetic Ingredients
LDL	– low-density lipoprotein
LED	– light-emitting diode
MAA	– Margarita Anti Acne
NPL	– New Product Laboratory
OTC	– over the counter
PHA	– polyhydroxy acid
PIF	– Product Information File
PAO	– Period After Opening
PEG	– polyethylene glycol
PIH	– post-inflammatory hyperpigmentation
PPG	– polypropylene glycol
QFD	– Quality Function Deployment
SCCS	– Scientific Committee on Consumer Safety
SPF	– sun protection factor
TEWL	– trans-epidermal water loss
U.A.B.	– uždaroji akcinė bendrovė (Lithuanian: limited liability company)
UV	– ultraviolet

1. INTRODUCTION

1.1. *Acne vulgaris*

Affecting up to 85% of individuals at some point in their lives, acne is the most prevalent skin condition worldwide (1). Although it is seemingly non-threatening to the overall health of sufferers, and indeed is often dismissed as a purely cosmetic concern, acne is not only a skin-deep issue: it can deeply impact self-perception, the psychological wellbeing, and even the social life of individuals, independently of its severity (2,3). The emotional suffering caused by acne should not be downplayed, and it is important to provide the large percentage of people afflicted by it an effective means of managing this condition.

Acne is a chronic problem, and for some it will persist beyond puberty and well into adulthood (4). While it is most often associated with teenagers and young adults, the incidence of adult acne is on the rise. There is no one definite cure for this skin condition, albeit research towards a potential vaccine is currently underway (5). Fortunately, it can frequently be managed with proper care, in the form of medication or an appropriate skin care regimen (6).

The constant innovations seen in the field of skin care and cosmetics (whether pertaining to formulation technologies, the discovery of new active ingredients, or novel information about the mechanisms of acne itself) drive the need for modernized product lines that allow users to manage mild to moderate cases without resorting to harsher treatments, or improve treatment adherence by mitigating the side effects of anti-acne drugs for more severe cases. Manufacturers also need to compete with other companies which release products at rapid rates to keep up with the demand for novelty. The beauty and personal care industry is expanding at an ever-accelerating pace, and is projected to reach 716.6 billion dollars by 2025 (7).

As such, reformulations are a routine part of the functioning of skin care manufacturing companies. Seeing as so many individuals struggle with acne and are therefore driven to seek skin care solutions, it is important to deliver updated and effective products, especially when dealing with a condition about which there are still many uncertainties being researched. This work will explore the process of reformulating one such anti-acne skin care line within the Margarita brand of cosmetic manufacturer BIOK Laboratorija U.A.B., in Vilnius, Lithuania, detailing the decision-making process and the steps taken to create a cohesive skin care regimen to assist in the management of acne.

1.1.1. Acne pathophysiology

To understand how to best address the issue of acne, it is crucial to first explore its underlying mechanisms. Unfortunately, there are still many gaps in our current understanding of this condition — mainly pertaining to which factors can trigger it — that pose hurdles to its management. However, its pathophysiology is well-established in literature, and there is new research that may help paint a clearer picture of its causes.

Acne vulgaris is a chronic inflammatory condition of the human pilosebaceous follicle (figure 1) which affects approximately 85% of teenagers, half of which will continue to suffer from it in their adult lives, having a prevalence of 40% among adult men and of 54% among adult women (8). It typically manifests as lesions on the skin: papules, pustules, comedones (open – referred to as ‘blackheads’ – or closed – ‘whiteheads’), or cysts (9). According to the type of lesions present, acne can be classified as inflammatory or non-inflammatory. Papules, pustules and cysts are more commonly found in cases of inflammatory acne, alongside redness, pain and swelling, whereas comedonal acne is considered non-inflammatory (4). Lesions occur most frequently on areas of skin that have a higher density of sebaceous glands, such as the face, but can appear across various other sites of the body as well (10,11).

The formation of an acne lesion depends on four major processes, namely: hyperkeratosis of the pilosebaceous unit forming a comedone; exacerbated sebum production stimulated by androgenic hormones; excessive proliferation of *Cutibacterium acnes* within the comedone; and inflammatory processes, which can stimulate all of the aforementioned factors (2).

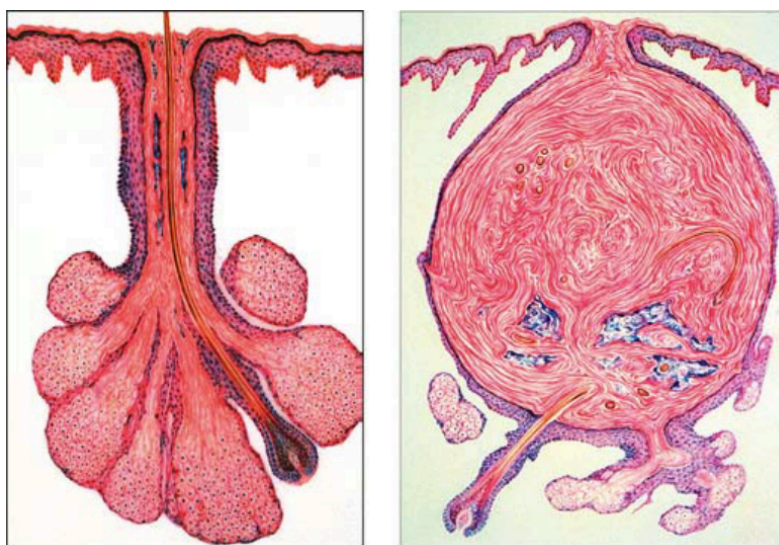


Figure 1: Histological view of the human pilosebaceous follicle: normal (left) and enlarged due to the formation of a comedone (right) (12).

When keratinocytes rapidly proliferate (hyperkeratosis) and become densely packed, they no longer can desquamate properly and thus the pilosebaceous follicle becomes blocked. These plugged-up follicles, which can also be designated as microcomedones, have been proposed to occur due to the action of inflammatory mediators, increased androgen levels, and variations in the lipid composition of sebum (2).

Sebum, a mixture of lipids (wax esters, triglycerides, free fatty acids, squalene, cholesterol and its esters) which functions as a lubricant and part of the skin's barrier function, is also involved in the pathophysiology of acne (13). Although individuals with acne tendentially perceive their own skin to be moderately to extremely "oily", heightened sebum secretion is not linked to a higher number of lesions, but rather to comedonal inflammation, therefore affecting the evolution of the lesion only after it has appeared, rather than causing its formation (14).

The regulation of seborrhea is complex and very dependent on hormone levels, of which the most discussed in the context of acne are androgens. Sebocytes with an increased sensitivity to androgens will proliferate and produce sebum at higher rates, and the involvement of these hormones in acne is supported by the absence of this affliction in castrated males, as well as individuals with non-functional androgen receptors (11,15). Estrogens are another class of hormones that affect the evolution of acne lesions, but their effect is opposite to that of androgens, by inhibiting the action of these on sebocytes, therefore downregulating sebum production (16).

The anaerobic, lipid-rich medium created within plugged-up comedones provides the ideal conditions for the proliferation of *Cutibacterium acnes* (formerly *Propionibacterium acnes*) — commensal, gram-positive bacteria which are found on the skin of almost all individuals and which are harmless under normal conditions (17,18). Indeed, research on the role of *C. acnes* in acne formation indicates that it is not necessarily an increased number of bacteria, but rather the proliferation of specific phylotypes over others, that is linked to inflammatory acne (19,20). *C. acnes* is also capable of forming biofilms, which improve its adhesion to the walls of the pilosebaceous follicle, its resistance to antibiotics, and promote the secretion of more pro-inflammatory substances (21). These pro-inflammatory compounds (bacterial lipases, chemotactic factors, hyaluronidases, proteases, cytokines, chemokines) are thought to be the main contributor to the part *C. acnes* plays in acne development, by promoting irritation, invasion of the follicle by neutrophils and macrophages, causing a pustule to form, tissue breakdown and scarring (2,22). *C. acnes* also appears to be implicated in the very earliest stages of formation of comedones, as it modulates the expression of integrins and filaggrin, which are involved in hyperkeratosis (15,23).

Inflammatory processes seem to be present from the onset of microcomedone occurrence as well, which has given rise to the hypothesis that the skin of individuals with acne may be naturally more prone to inflammation (24). Sebum production can also be upregulated by certain inflammatory mediators; this exemplifies the interconnectedness of these four steps of acne formation, which act synergistically and not in a merely sequential chain of events (2).

1.1.2. *Risk factors*

Much has been hypothesized about potential triggering factors of acne, in scientific circles and mainstream empirical wisdom alike. As a result, acne sufferers will routinely receive a wide array of advice on how to deal with their condition, from sources that contradict one another and generate confusion. Whether one should address their lifestyle and diet, overhaul their cosmetic routine, or simply lay the blame at the feet of genetics — these questions remain somewhat unclear, and therefore research continues towards establishing a more defined causal profile.

Although its mechanisms of heredity are not yet wholly understood, twin studies have highlighted the genetic component of acne, thought to be linked to multiple genes that regulate androgen expression or maturation of pilosebaceous follicles (2). Other intrinsic factors, like age and gender, play major roles: in adolescence, acne is present at near-100% rates in girls and boys alike. Whereas boys tend to experience more severe acne during late puberty, girls more commonly have an earlier onset of the disease and are more likely to carry it into postpubescence and adulthood (25). The menstrual cycle has also been linked to acne breakouts (2).

Regarding hygiene habits and cosmetic usage, much has been said about their impact on acne. Indeed, individuals with acne often internalize the popular associations between acne and dirtiness, impurity or uncleanness, and extend them to their own persons, which has a devastating toll on self-esteem (3). In truth, as previously explored, acne is often due to intrinsic factors, whether they be genetic or hormonal in nature. However, cosmetic and hygiene routines do play a role in comedogenesis in some cases, although not always in the ways emphasized by popular knowledge. For instance, many individuals with oily, acne-prone skin tend to overzealously cleanse it, stripping the skin of its natural moisture and causing not only irritation, but also an impoverished skin microbiota which becomes more susceptible to bacterial imbalances, such as the unchecked proliferation of *Cutibacterium acne* (3,26,27). So far, there is no conclusive evidence correlating acne to sweat or to frequency of washing. On the other hand, ‘pomade acne’, or

acne venenata, is a form of the disease triggered by the use of heavy, greasy cosmetic products (for example, hair products commonly used by African American populations), or ingredients which are generally considered to be comedogenic (4).

Chemical triggers, such as smoking or drugs, may also alter the chances of acne breakouts. In the case of tobacco smoking, the data currently available is conflicting: a study among European youths indicated an inverse relationship between it and self-reported acne cases (28), whereas other research correlates a higher number of cigarettes smoked per day with higher acne severity (4). The ethical implications of further research on the tobacco-acne relationship hinder the obtainment of any clear answers, due to the harmful health effects of smoking. Medications, too, have been blamed for acne breakouts. Corticosteroids, androgens, progestin-based oral contraceptives, lithium, hydantoins and oncological drugs targeting epidermal growth factor receptors all have been observed to cause acneiform eruptions, mainly papules and pustules and with an absence of comedones (29).

In some instances, environmental conditions such as the climate (namely, humid and hot weather) can worsen acne (9). Solar exposure also contributes to skin inflammation, despite the popular notion that it can reduce acne lesions. Currently, there is not enough evidence to support this claim. However, research on blue, blue-red and infrared light therapy points towards some potential short-term benefits, although more studies are still necessary to clarify the effectiveness of this therapeutic approach (30). Nevertheless, cosmetic appliance manufacturers have used this as the underlying principle for an array of skin care gadgets now commercially available, such as blue or red light-emitting diode (LED) face masks (31).

One of the most oft-discussed topics when it comes to acne is diet and its potentially triggering or healing properties when managing the disease. Although an oft-cited 1969 study claimed to disprove the relationship between chocolate and acne (32), its results have been called into question by more recent research, which seems to indicate a correlation between chocolate consumption and increased acne incidence (33–35). Cocoa in and of itself may not be an issue, but frequently it is associated with high glycemic index foods, which cause a state of hyperinsulinemia in the body. This creates hormonal cascades that increase the levels of free insulin-like growth factor (IGF)-1, triggering unregulated growth of skin tissue, as is the case of hyperkeratosis, as well as higher levels of androgens that contribute to comedogenesis (36,37). Therefore, current research suggests that acne patients may benefit from a diet based on foods with a low glycemic index.

Sharing a similar mechanism of action in that they also induce IGF-1 synthesis, dairy foods have been pointed out by several studies as another culprit. Skimmed milk, in particular, appears to have more of an impact on IGF-1 plasma levels, and its processing

leads to a decreased concentration of the estrogens it contained, which counteract the comedogenic action of IGF-1-mediated androgen spikes. Similarly, it has been suggested that whey proteins also have acne-inducing properties (38). A meta-analysis published in 2018 supported the positive link between dairy and acne and the particular effect of skimmed milk; consumers of dairy foods were 16% more likely to have moderate to severe acne, although no relationship was observed with regards to mild acne. This association was strongest in Europe and North America, and was not observed in other regions (8).

The Western diet is typically very rich in hyperglycemic carbohydrates and cow's milk; the introduction of this type of diet in populations that previously had different eating habits corresponded to an increased incidence of the condition (39). Other predisposing aspects of the Westernized lifestyle include disrupted sleeping patterns (40), high levels of stress (4,41), and a cultural emphasis on hygiene and highly sanitized environments, which contribute to a loss of diversity among the cutaneous microbiota and therefore potentiate the imbalanced proliferation of acneogenic *C. acnes* (3,42,43). Overall, the joint contributions of each of these lifestyle factors help to shed some light on the ubiquity of acne, particularly among Westernized populations; however, further research is still needed to assess the individual impact of each risk factor and how to best prevent the onset of this skin condition.

1.1.3. The impact of acne on quality of life

Although at first glance acne seems to be a purely cosmetic concern, it has an impact that is much more than skin-deep. In the United States of America alone, nearly 4 billion dollars are spent every year due to the direct and indirect costs of acne management; when that figure is adapted to include the intangible costs from its impact on quality of life (estimated by inquiring about acne sufferers' willingness to pay for relief of symptoms), it rises to 15 billion dollars. The financial burden of acne, which reflects its psychological consequences, falls disproportionately on women and minorities, not only in prevalence but also in their severity (44). These numbers adequately represent how major the effects of acne on the lives of those afflicted can become.

The emotional distress caused by acne is not limited to its more severe forms; even mild to moderate cases, across all ages and genders, suffer from it (2). Unemployment rates are higher among acne patients, who are more prone to self-consciousness, social isolation, aggressive behavior, and suicidal ideation (3,45). Up to 21% of individuals with acne may meet the criteria for body dysmorphic disorder (BDD), a psychiatric diagnosis defined as "a preoccupation with a slight or imagined defect in appearance that causes significant disruption in daily functioning" (46). Additionally, other psychological

comorbidities of acne include anxiety and depression. Beyond mere ideation, the rates of suicide completion among acne patients mean that, despite generally presenting little risk of systematic physical symptoms, the morbidity of acne should not be underestimated (47).

Somewhat paradoxically, while the results of treatment with isotretinoin seem to help improve the psychological morbidity among patients with acne, the treatment with oral retinoids itself has also been linked to depression throughout its duration, potentially due to the intensity of its side effects, which can compromise patient compliance and create aesthetic concerns and discomfort (flakiness, dryness, cracking of the skin) in addition to that of the pre-existing acne breakouts (48,49). Therefore, the selection of an adequate medical response to acne cases of any severity is crucial to the psychological wellbeing of the patients, and alternative or additional methods of managing the condition — for instance, an appropriate skin care regimen — are greatly helpful in increasing quality of life.

1.1.4. Acne management: medication and skincare

Despite its ubiquity, the diagnosis of acne cases is complicated by the marked polymorphism of this skin condition, which ranges in severity and presentation, and therefore contains an array of subtypes (50). Further difficulties arise from the discordance between existing scales for evaluation of acne severity. Although their reliability has been rated as weak to moderate, medical practitioners as well as researchers commonly resort to simplified scales, namely the classification of acne as mild, moderate or severe (51). The currently available treatment guidelines are based on evaluation of acne cases according to these severity scales. These guidelines include both topical and systemic approaches, as well as maintenance treatments (6).

One of the systemic therapies that has been used to combat acne involves the use of antibiotics, such as clindamicyn or erithromicyn; however, due to the increasing commonness of antibiotic-resistant *C. acnes* strains, antibiotics are not recommended as a monotherapy, but rather in combination with other approaches (52). Antibiotics may also be applied topically, with the same limitations regarding bacterial resistances (22). Androgen blockers, such as spironolactone, have also been used systemically to treat adult female acne, although high-quality trials that further prove their effectiveness are still lacking (53). Combined oral contraceptive pills that contain ethinylestradiol and progestins that inhibit ovarian androgen production (especially cyproterone acetate) are also commonly used as part of the treatment of female acne patients (54); however, these drugs have been shown to increase the risk of venous thrombosis (55). Table 1 details these and other recommended acne treatments.

Table 1: Acne treatment recommendations according to the European S3 Guidelines, adapted from Nast *et al.* (6).

	Comedonal acne	Mild/moderate papulopustular acne	Severe papulopustular/moderate nodular acne	Severe nodular/conglobate acne ^{*4}
<i>Strong recommendation</i> ^{*1}	No evidence	Adapalene + benzoyl peroxide (BPO) (f.c.) or Adapalene + clindamycin (f.c.)	Isotretinoin ^{*1}	Isotretinoin ^{*1}
<i>Moderate recommendation</i>	Topical retinoids ^{*3}	Azelaic acid or BPO or topical retinoids ^{*3} or systemic antibiotic ^{*2} + adapalene ^{*10}	Systemic antibiotic ^{*5} + adapalene ^{*10} or systemic antibiotic ^{*5} + azelaic acid ^{*8} or systemic antibiotic + adapalene + BPO (f.c.)	Systemic antibiotic ^{*5} + azelaic acid
<i>Weak recommendation</i>	Azelaic acid or BPO	Blue light or oral zinc or topical erythromycin + isotretinoin (f.c.) or topical erythromycin + tretinoin (f.c.) or systemic antibiotic ^{*2} ^{*5} + BPO ^{*7} or systemic antibiotic ^{*2} ^{*5} + azelaic acid ^{*10} or systemic antibiotic ^{*2} ^{*5} + adapalene + BPO (f.c.) ^{*9}	Systemic antibiotic ^{*5} + BPO ^{*7}	Systemic antibiotic ^{*5} + BPO ^{*7} or systemic antibiotic ^{*5} + adapalene ^{*9} ^{*10} or systemic antibiotic ^{*5} + adapalene + BPO (f.c.) ^{*9}
<i>Alternatives for female patients</i>	—	—	Hormonal antiandrogens + topical treatment or hormonal antiandrogens + systemic antibiotics ^{*6}	Hormonal antiandrogens + systemic antibiotics ^{*6}

f.c.: Fixed combination

^{*1} Use of a lower recommendation strength treatment may be necessary due to limitations (financial, legal, drug availability and licensing, etc.).

^{*2} Systemic treatment initiation can be recommended in case of more widespread/severe disease.

^{*3} Adapalene is preferable, rather than tretinoin/isotretinoin.

^{*4} Systemic treatment with corticosteroids may be considered.

^{*5} Doxycycline and lymecycline.

^{*6} Weak recommendation.

^{*7} Indirect evidence from a study also including chlorhexidine based on expert recommendation.

^{*8} Indirect evidence from nodular and conglobate acne and expert opinion.

^{*9} Indirect evidence from severe papulopustular acne.

^{*10} Only studies with systemic antibiotics + adapalene, isotretinoin and tretinoin (combination therapy) were considered based on expert recommendation.

Other systemic treatments include oral retinoids, the most common of which — isotretinoin — causes the apoptosis of sebocytes and subsequent shrinking of sebaceous glands (52). Despite its undeniable effectiveness that makes it the gold standard for more severe, stubborn cases of acne, its side effects are considerable and can compromise patient compliance (56). Most visibly, isotretinoin causes extreme dryness of the skin and mucosae that can become uncomfortable or even painful, but other effects can show up as laboratory abnormalities — namely, as increases in liver enzymes, triglycerides, cholesterol and low-density lipoprotein (LDL) fraction (52). Furthermore, it is highly teratogenic (57). The link between isotretinoin and depression remains controversial among researchers, but current recommendations are to monitor any psychiatric symptoms that may arise during treatment (52). Because of this, isotretinoin is usually only used in very severe cases or after other treatment methods have been exhausted without success.

Retinoids are also used topically, both as active ingredients in over-the-counter (OTC) cosmeceutical products, or as active substances in prescription drugs, such as adapalene, tretinoin and tazarotene; while these options still often encounter the side effect of skin dryness, they avoid the remaining harsher, systemic effects (58). Also available as a topical treatment, benzoyl peroxide is often used in combination with other methods herein described, although its side effects also include dryness and irritative contact dermatitis; for this reason, its use is recommended in concentrations up to 5% only (54).

Azelaic acid is another topical option, at a concentration of 15 to 20% and used alone or in combination with other treatments (54,59). Because it shows similar efficacy to other treatments for mild to moderate acne, yet does not cause systemic side effects, azelaic acid is considered the first line of treatment for less severe cases; it also reduces post-inflammatory hyperpigmentation (PIH), and is considered safe for pregnant and breastfeeding women by the US Food and Drug Administration (FDA) (52).

Beyond the scope of drug-based treatments, other adjuvant therapies have been recommended for acne cases, depending on their severity: these include mechanical procedures, like the draining of cysts, microdermabrasion or the manual removal of comedones; chemical peels; laser procedures; and finally, the day-to-day management of this condition with resort to skin care products that are suited to the individual's skin type (52).

These cosmetic measures improve the quality of life of acne sufferers by decreasing discomfort and self-consciousness, and they can also help in increasing compliance with drug-based therapies by minimizing some of their undesirable side effects (60). However, overtreatment with cosmetics is counterproductive and can lead to comedogenicity and irritation (61). Additionally, aggressive advertisement campaigns that target already-insecure individuals can lead them to spend large sums on ineffective and irritating OTC

products, and to delay seeking medical guidance (52). The importance of educating consumers on the nature of their skin condition and its management thus becomes self-evident; likewise, the formulation of skin care products for acne-prone skin must be done carefully and respectfully of the pathophysiology and trigger factors that underly this disease as well as the common needs of this skin type.

1.2. Formulating skin care for acne-prone skin

As previously discussed, skin care is an invaluable tool for those afflicted with acne, who are usually more predisposed to try new cosmetic products in hopes that they will solve their skin troubles. However, the wrong type of cosmetics can be more harmful to skin health than the absence of a skin care routine — this is indicated by the existence of acne subtypes such as *acne cosmetica* or *acne venenata*, caused by the comedogenic properties of certain types of product, such as hair pomades or heavy, occlusive creams (2).

‘Non-comedogenic’ claims are a hot buzzword in the skin care industry; however, at present, we lack the means to objectively assess the comedogenic potential of ingredients or finished formulations (62,63). Although regulatory bodies such as the FDA do not have a legal definition nor do they provide validation methods for this claim, it is understood both by companies and consumers to imply that the finished product will not clog the pilosebaceous follicle via hyperkeratosis, the first step in comedogenesis (63). However, creating a definitive list of comedogenic substances formulators ought to avoid has proven to be challenging, since historically used methods, such as testing on rabbit ears or the upper back skin of humans, yield inconsistent results that cannot always be extrapolated to the behavior of human facial skin (62,64,65). Despite this, since the data obtained through these methods is the closest approximation formulators have, ingredients found to be comedogenic by the rabbit ear or upper back methods are still frequently avoided in cosmetics meant for acne-prone and oily skin (66).

The three mainstays of a skin care routine for acne-prone individuals, according to current dermatological recommendations, are a mild, low-pH cleanser, an oil-free moisturizer capable of soothing irritation without clogging the pilosebaceous follicle, and — as indicated for any and all skin types — a broad-spectrum sunscreen with a sun protection factor (SPF) of 30 or above (61,67). Products that act as vehicles for oil-controlling, anti-microbial, keratolytic or anti-inflammatory active ingredients are also invaluable (61). In the following sections, the basic characteristics of each of these acne-specific product types will be outlined.

1.2.1. Cleansers

Cleansers are an integral part of the skin care routine of most acne sufferers, stemming from the folk wisdom that acne must derive from uncleanliness. In fact, a cross-sectional survey of females with facial acne revealed that over one quarter (27.9%) believed that frequent washing could improve their breakouts (26). Although this idea is not wholly correct, it is true that an adequate cleanser can benefit acne-prone skin — but it is also equally true that the wrong cleanser can compromise cutaneous health.

The skin surface is acidic in pH, resulting from a pH gradient across its stratum corneum; literature values range from 4 to 6, affected by intrinsic factors such as age, skin site, and pigmentation, and extrinsic ones like diet, hygiene habits, sweat, and sebum, but several sources point towards the average value being below 5 (68–70). This comprises the so-called ‘acid mantle’ which appears to be important in the maintenance of good skin health, due to its role in maintaining the barrier function, regulating stratum corneum cohesion and desquamation, and enacting its antimicrobial properties (68). Related to the latter point, *C. acnes* growth *in vitro* is significantly impaired at pH levels below 6, but frequent washing with even a “neutral” soap or syndet cleanser (pH 7) could cause both short- and long-term skin pH perturbations that create more favorable conditions for the proliferation of acne bacteria (71). Thus, the classical understanding of pH-neutral differs from the more apt concept of a “skin-neutral” product, which would ideally have a pH of about 4.5 to 5.5 (70).

Formulators working with products at lower pH levels face a particular set of challenges, mainly related to thickener effectiveness, which tends to decrease in acidic environments for many commonly used viscosity modifiers, like carbomers (72). However, a lower pH also offers its own formulation advantages — it allows for an enhanced efficacy of alpha- and beta-hydroxyacids (AHAs and BHAs), commonly used as chemical exfoliants for acne-prone skin, as well as other acidic active ingredients like ascorbic acid, preservatives, like benzoic or sorbic acid, and their boosters, in addition to creating a less inviting environment for microbial growth (73).

A cleanser’s pH is not the only parameter that needs to be controlled for use on acne-prone skin. Surfactant type has also been linked to the effect of a cleanser on acne; one study reported a slight increase in inflammatory acne lesions for individuals using traditional soap bars, as opposed to a decrease for those using a syndet cleanser (74). Syndets (a designation derived from “synthetic detergents”) are more acidic and less irritating than traditional soaps, permitting their incorporation in skincare regimens for users that may already be subjected to sensitizing treatments such as oral retinoid therapy (75).

The sensorial properties they contribute to the product are different from what users may expect, specifically when it comes to the amount of foam produced and its stability, which are lower than with traditional soaps, and they create difficulties in the production of solid bar-type products (76,77). However, they remain a preferable option for acne-prone skin, in alternative product forms such as cleansing gels or foams.

Cleansers are rinse-off products, meaning that any active ingredients included in the formulation will have a limited contact time with the skin and therefore their effectiveness is reduced compared to leave-on products. Nevertheless, many cleansers in the market today feature active ingredients such as AHAs, keratolytic enzymes, salicylic acid, skin-soothing agents like bisabolol or allantoin, or phytoextracts that boost marketing claims. Some cleansers will also include physical exfoliation with granular particles or oil absorbency and astringency thanks to bentonite or kaolin clay; however, these features may exacerbate irritation of the skin if it suffers from very reactive inflammatory acne (61).

Although there is still no definite answer on what the ideal frequency of washing is, current dermatological consensus recommends twice-daily washing with mild cleansers (27). As explored above, this concept of mildness encompasses not only a skin-neutral pH and a formulation based on less aggressive surfactants, but also the avoidance of common irritants, like harsh scrubbing particles (61).

1.2.2. Moisturizers

There is a certain reluctance by acne-prone individuals towards consistent use of moisturizers, resulting from their perception that these can exacerbate the “greasiness” of their skin. However, most persons across all skin types benefit from the regular use of a moisturizer, and acne sufferers are not exempt from this, although they do require certain product specifications (78).

Three main types of ingredients can be found within a moisturizer, divided by their function: emollients, humectants and occlusives. Emollient ingredients soften and smooth the *stratum corneum*, and so they combat skin flakiness, a common side effect of acne therapies (79,80). Humectants are hydrophilic molecules that deliver and attract water to the skin surface, without any greasy sensation. Lastly, occlusive ingredients form a thin hydrophobic film atop the skin, which helps reduce trans-epidermal water loss (TEWL) (78,81). TEWL is increased when the skin barrier function is compromised, for instance by inflammatory and irritative events like the ones involved in acne (82). Therefore, even if their relative proportions may require modulation in order to achieve a sensorial performance

that ensures user satisfaction, all three types of moisturizing ingredients can be beneficial for acne-prone skin.

However, emollients and occlusives have their own pitfalls and must be selected carefully to avoid them — the former have a tendentially oilier feel, whereas the latter can clog pores and incite hyperkeratosis. As such, formulators still often depend on lists of common comedogenic triggers to avoid, although the methods by which their data were obtained are not entirely representative of the human skin's response (62). It is also generally misadvised to include oils in formulations meant for individuals with acne (60). Nevertheless, newer research being carried out on the skin-healing potential of natural oils, like rosehip oil (which contains natural derivatives of retinol, and appears to possess scar minimizing properties) suggests that they may yet have a place in acne formulations (83).

Moisturizers are better vehicles for active ingredients than rinse-off products, such as cleansers, due to their prolonged period of contact with the user's skin. A moisturizing product need not be a standard cream formulation — the number of sub-categories that refer to various textures and formulation types is ever-increasing, and includes hydrating toners, lotions, serums, essences, gels and gel-creams, although the distinction between these designations can be blurry at times and is often dictated by marketing decisions.

Another key functionality of moisturizing formulations is their ability to serve as vehicles for ultraviolet (UV) filters, providing sun protection in the daytime, a staple of preventive skin health (67). Although acne sufferers need to be particularly zealous about sunscreen use, in order to prevent inflammation and the development of hyperpigmented scars, as well as due to the photosensitizing effect of many anti-acne therapies and active ingredients (for instance, retinoids, topically-applied acids) (60), the use of a broad-spectrum sunscreen with a sun protection factor (SPF) of 30 or above is recommended for the entire population and is not an acne-specific concern; as such, the exploration of sunscreen formulations falls beyond the scope of this work.

1.2.3. Active ingredients

Within the scope of the cosmetic industry, active ingredients are oftentimes the basis for marketing claims that mark a product as effective or innovative, and therefore they are frequently the focus of new research in the field. Thus, there are a few ingredients whose use against acne is substantiated by a significant body of evidence, as well as emerging actives that provide interesting avenues for research. Some of these ingredients which are commonly seen in modern anti-acne skincare are presented in table 2.

Table 2: Selected ingredients used in anti-acne cosmetic formulations and research substantiating their effectiveness.

	Ingredient	Actions	References
<i>AHAs</i>	Glycolic acid	Keratolytic	(84,85)
	Azelaic acid	Antimicrobial; keratolytic; sebostatic	(86)
	Mandelic acid	Antimicrobial; keratolytic	(87)
<i>PHA</i>	Gluconolactone	Epidermal turnover enhancer; hydrating; antioxidant	(88,89)
<i>Liposoluble acid</i>	Salicylic acid	Keratolytic; sebostatic; anti-inflammatory	(90)
<i>Vitamin analogs</i>	Nicotinamide	Anti-inflammatory; sebostatic	(91,92)
	Retinol	Antiproliferative	(93)
<i>Inorganic elements</i>	Zinc	Anti-inflammatory; sebostatic	(94,95)
	Sulfur	Keratolytic	(96)
<i>Plant-derived</i>	Tea tree oil (<i>Melaleuca alternifolia</i>)	Broad-spectrum antimicrobial; anti-inflammatory	(97–99)
	Tea extract (<i>Camellia sinensis</i>)	Antioxidant; antimicrobial; antiandrogen; sebostatic	(100,101)
	Witch hazel extract (<i>Hamamelis virginiana</i>)	Anti-inflammatory; antimicrobial	(102)
	Cannabinoids	Sebostatic; anti-inflammatory; antiproliferative	(103–105)

Perhaps best known of all anti-acne ingredients, salicylic acid (frequently designated as a BHA, although the accuracy of this nomenclature has been disputed by some authors) features in many over the counter (OTC) products, from cleansers to spot treatments (106). Its liposoluble nature allows it to enter the lipidic moiety of the pilosebaceous follicle and exert its keratolytic, sebostatic and anti-inflammatory actions (90). Another group of organic acids that are heavily used for acne-prone skin, AHAs — including glycolic, citric, mandelic, lactic, azelaic, and mallic acids, among others — are chemical exfoliants, prized mainly for their keratolytic effect (84). Of these, azelaic acid deserves special mention; as previously discussed, it is well documented in its use as a prescription treatment for acne, but it is also available in OTC products, as a keratolytic, anti-inflammatory, anti-microbial and sebostatic agent (86). Poly-hydroxyacids (PHAs) like lactobionic acid or gluconolactone offer an alternative to AHAs, with lower irritation potential so as to achieve a gentle chemical exfoliation (88,106).

Retinoids, which are vitamin A analogs, are also not limited to prescription products, and may be found in OTC skin care; they prevent the overgrowth of keratinocytes that results in hyperkeratosis, and promote skin cell turnover, which helps improve the texture of the skin (93). However, topically applied retinoids can still induce xerosis, irritation and

desquamation in a process commonly known as ‘retinization’; this may discourage entry-level users from incorporating them into their skin care routine (107).

Another popular vitamin analog that has gained traction as an acne-fighting active is niacinamide (also designated nicotinamide), an anti-inflammatory and sebostatic ingredient (91,92). In the realm of inorganic elements, zinc and sulfur also have a history of use for this purpose, the former as an anti-inflammatory and sebostatic agent and the latter as a keratolytic (94); however, their sensorial characteristics pose formulating challenges that limit their popularity.

Another sector of ingredients that is ever-increasing in popularity due to the growth of the ‘green beauty’ and ‘natural skin care’ sectors is that of plant extracts and other plant-derived materials. Green tea (*Camellia sinensis*), tea tree (*Melaleuca alternifolia*), witch hazel (*Hamamelis virginiana*) and the recently-trending *Cannabis* derivatives all appear to have some benefits for the management of acne (97–100,102–105,108), although in some cases the existing evidence is far from conclusive. Despite this, they are widely used in products already in the market.

Essential oils are a subset of plant products that are also frequently used, whether as active ingredients or as fragrances; however, due to their higher concentration in bioactive compounds when compared to plant extracts, they can pose problems for sensitized skin and induce photosensitivity or contact dermatitis, which can outweigh the benefits they may have to offer (109,110).

Ideally, an active ingredient employed in an anti-acne formulation should target one or more of the four pillars of the pathophysiology of this condition: hyperkeratosis, seborrhea, *C. acnes* proliferation, and inflammation. If a new ingredient shows biological activity in these areas, it may be interesting to further research its performance on the skin, but the overall performance of the formulation — not only the isolated active ingredients — must also be taken into account. Likewise, results obtained from *in vitro* trials may not necessarily translate to *in vivo* or in-use circumstances.

At present, there is a lack of clinical-strength, placebo-controlled trials on human skin to substantiate the use of newer, trendier active ingredients, which are appealing as a marketing strategy but do not possess the scientific backing of better-researched ingredients like retinoids, BHA/AHAs, or azelaic acid.

1.3. Aims of the internship project

In light of this information about the relationship between acne and skin care products, the present internship was planned out in partnership with BLOK Laboratorija,

U.A.B., with the broad objective of developing cosmetic products suitable for acne-prone skin.

The specific aims of the internship project were:

- To reformulate a pre-existing line of anti-acne skin care products, with the goal of creating a cohesive and comprehensive routine for acne-prone individuals;
- To accompany the products within the line through the various steps of product development, from their conceptualization to the preparation for their release;
- To observe and learn the inner workings of a cosmetics development company and its production lines;
- To gain a practical understanding of cosmetic formulation, cosmetic ingredients and their suppliers.

2. REFORMULATION OF THE MARGARITA ANTI-ACNE LINE

BLOK Laboratorija, U.A.B., the largest manufacturer of cosmetics in Lithuania, was the receiving institution of this internship project. The private company was founded in 1988 by scientists in the area of biochemistry, and since then it has become a leader of the beauty and skin care market among the Baltic states (111). Currently, it is led by CEO Romualda Stragienė and employs more than 60 workers (112). As of 2020, BLOK produced more than 210 different face, body and hair care and oral hygiene products, although its ranges and brands have undergone updates and reformulations. Beyond the local Baltic market, BLOK also exports its products to thirty-five countries (Great Britain, the Benelux, Germany, Poland, Finland, among others); according to a report dated to 2018, exports comprise about 30% of the company's total turnover, which in that year amounted to a total of 8.7 million euros in sales (112). Currently, construction work is under way on a new production and headquarters site, which will have a sustainable infrastructure in the A++ energy class and a greater size allowing for scaling-up and optimization of the production operations (113).

BLOK was the parent company of popular brands among Baltic consumers such as Rasa, Aras, BLOK Dermatology, Margarita, and Thai (111). Of these, only Margarita is still produced; the remaining brands' portfolios have been rebranded into newer concepts to create Kilig, in a move to modernize their image (114). The company's best-selling brand at present, however, is Ecodenta, which focuses on dental and oral care (figure 2).



Figure 2: Production line at the BLOK factory facilities, depicting the loading of toothpaste tubes onto the filling machine (134).

Whereas Kilig aims to capture the interest of young, urban consumers, offering them everyday skin care with a playful, simple and ‘feel-good’ approach, and Ecodenta seeks to integrate natural ingredients and a science-based approach into an innovative range of oral care products, Margarita is the oldest brand of the three, and it has become a mainstay in a large portion of Baltic homes. Its product lines range from hair and body care to facial skin care, deodorants, lip and hand care, and intimate hygiene.

The concepts behind Margarita are tied to “Baltic nature”, “Baltic traditions” and “Baltic skin”, making it a brand that is less popular outside this region, but that has accrued a very loyal following across generations among Lithuanians, Latvians and Estonians. The plant extracts featured in formulations and highlighted in each product’s marketing are tendentially those found in local nature: sea buckthorn oil, oat milk, bilberry extract, cucumber extract, to name a few. Furthermore, product concepts often borrow from Lithuanian beauty traditions, such as hair washes including hops or facial masks with honey. The products are developed with the characteristics of the average Baltic consumer’s skin in mind, namely its sun sensitivity due to lack of skin pigmentation, and its tendency towards redness and dehydration as a consequence of very cold winters.

Enhancing this concept of accessible familiarity, Margarita products are formulated with high percentages of organic and/or natural ingredients, and oftentimes certified through COSMOS or ECOCERT. It also places itself as a very affordable brand, available through large supermarket chains and budget cosmetic retailers, which has contributed to its ubiquity in Lithuanian homes. Beyond the Margarita main line, the brand has an assortment of more specialized product ranges, including Margarita Eco, Sensitive Skin, Kakės Makės (a children’s line in collaboration with a popular cartoon), Beatos Virtuvė (a collaboration with a Lithuanian lifestyle influencer), for Men, Anti Age, and the focus of the present work — Margarita Anti Acne (MAA).

2.1. Characterization of the original Margarita Anti Acne line

The currently available MAA line features five products: a spot treatment gel, a cleansing toner, a face wash, a 3-in-1 face scrub/mask/wash, and a face gel-cream (figure 3). The main active ingredients of the product line are AHAs (lactic and glycolic acids) and salicylic acid, supplemented by botanical extracts of grapefruit and raspberry, the latter of which features prominently in the line’s packaging and marketing material, as well as its scent.



Figure 3: Promotional image of the Margarita Anti Acne line, featuring, from left to right, the spot treatment gel, cleansing toner, facial wash, three-in-one scrub/mask/wash, and gel-cream moisturizer (135).

Looking into each product, the face wash is a gel-type formulation with a mild surfactant system. The toner features astringent ingredients in addition to glycolic acid to achieve a pore size-reducing effect. The gel-cream has a lightweight consistency, and it contains a starch-derived mattifying agent. The scrub is primarily a physical exfoliant, relying on raspberry seed particles; the presence of clay allows it to function as an absorbent mask as well. All products have a preservative system based on sodium benzoate and potassium sorbate, with the exception of the scrub, which relies on phenoxyethanol and ethylhexylglycerin.

2.2. New product concepts

The MAA line was released in 2017 and it performed well in sales, but based on consumer feedback and the desire to keep up with new developments in the area, it was decided that a reformulation was necessary at this point, to create a product lineup with a more mature and advanced feel, attractive not only for teenage acne sufferers but for adult users who are increasingly more knowledgeable about skin care. The main criticisms found in product reviews addressed the high irritation potential of some products within the line (namely, the toner and the scrub), as well as the intensity of the fruity fragrance featured in all of the products. Furthermore, the Marketing department sought to replace the star botanical extracts to more closely reflect the concept of “Baltic nature”, changing the scent to match.

As is the standard with Margarita products, preference was given to ingredients of natural origins, with the goal of having them comprise 80% or more of the formulation. Although natural-origin ingredients are not necessarily safer, more effective or even more sustainable than their synthetic counterparts, the 'green beauty' trend has taken root and now strongly influences many consumers' preferences when selecting their skin care products (115,116).

Innovative products, too, can sway consumers' preferences, and the cosmetics industry is very novelty-driven; therefore, to remain relevant, brands will often opt for new, creative formulation types when releasing or reformulating a product. This was reflected in the new product line-up for the MAA line. While the cleansing gel, toner and gel-cream remained broadly within the same formulation types (although the face wash was initially posed to become a self-foaming liquid product), the product that saw the most changes was the 3-in-1 scrub/mask/wash. Following the loss of popularity of physical scrubs among acne sufferers, due to their tendency to exacerbate inflammatory reactions (61), it was proposed to attempt a *gommage*-type formulation containing AHAs, combining gentle physical and chemical exfoliation. The French word *gommage* refers to the act of erasing pencil marks with a rubber, alluding to the function of this type of product: it is applied as a paste to the skin and allowed to dry slightly, then rubbed off, lifting dead skin cells along with the product residue and forming small 'balls' or 'pills' of material. *Gommage* products are already common within the Asian beauty market, where they are better known as 'peeling gels', but they are not as common among Western brands, which have long given preference to scrubs relying on exfoliating granules. Based on the former product's multitasking action as a mask as well as a scrub, the *gommage* was envisioned as a similarly multifunctional product capable of being used as a mask.

Thus, the reformulated line was comprised of four steps (having removed the spot treatment gel from the product lineup, due to low interest from consumers), encompassing a full routine for acne sufferers, with the exception of sun protection: a mild, low-pH facial cleanser; an exfoliating toner which would serve as the main vehicle for AHAs; a lightweight, soothing gel-cream moisturizer; and a multifunctional *gommage* mask for occasional use.

2.3. Selection of star active ingredients and fragrance

The choice of active ingredients was made in tandem with the BLOK Marketing department. The main anti-acne actives present within the original line, AHAs (glycolic and lactic acid, specifically), were maintained for the reformulated versions. Furthermore, to reinforce the more professional and effective image of the new line, it was also decided that

the percentage of active acids should be increased slightly, given that higher concentrations of AHAs allow for a more potent exfoliating effect (117).

The original MAA line also included salicylic acid in several of its products. However, the Danish Centre on Endocrine Disruptors considers, in a recently published report, that there is sufficient evidence to consider salicylic acid an endocrine disruptor (118). While the Scientific Committee on Consumer Safety (SCCS)'s opinion on salicylic acid, published in June 2019, does not consider the report sufficient for reclassifying salicylic acid as an endocrine disruptor, it also admits the possibility of reevaluating the available data in the future and revising this stance (119). Presently, the EU regulations allow the use of salicylic acid as a preservative in concentrations up to 0.5%, and for other purposes in concentrations up to 3.0% in rinse-off hair products and 2.0% in other products (excepting body lotion, eye shadow, lipstick, mascara, and roll-on deodorant, where the maximum permitted concentration is 0.5%) (120). Nevertheless, given the uncertainties posed by some of this novel research, the New Product Laboratory (NPL) direction and Marketing department elected to eliminate the pure ingredient from formulations and to replace it with a botanical alternative.

The botanical extracts included in Margarita formulations are featured with emphasis on the product packaging and marketing materials, to appeal to consumer sensibilities that favor natural ingredients, as well as uphold the concept of "Baltic nature" at the core of the brand's image. As such, special thought was given to which botanical extracts to include in the reformulated line, given that the grapefruit and raspberry extracts were deemed too disconnected from "Baltic nature" and from the latest research on anti-acne skin care.

A preliminary round-up of potential extracts and research on their benefits for acne-prone skin was conducted. Criteria for consideration of extracts included their traditional use in Baltic regions, and the existence of promising evidence for their effectiveness against acne. Rose hip (*Rosa canina*), yarrow (*Achillea millefolium*), juniper (*Juniperus communis*), fennel (*Foeniculum vulgare*), white deadnettle (*Lamium album*), apple (*Pyrus malus*), and white willow (*Salix alba*) were all considered, as well as complex actives containing several extracts offered by a number of cosmetic ingredient suppliers. All the options were discussed with the Margarita marketing director, and several samples from different suppliers were also evaluated. The final choice of botanical extracts settled upon apple and white willow bark, both as 1:1 water/glycerin extracts.

White willow bark extract, rich in salicylic acid derivatives, tannins, flavonoids and catechins, was selected as a naturally occurring alternative to pure salicylic acid. Its use as an anti-inflammatory, astringent and antiseptic has deep roots in historical customs, with references in pharmacopoeias dating back to ancient Sumer, Egypt and Greece for

treatment of aches, fever and inflammation (121). Its main bioactive components, salicylates, are derived from salicylic acid, which has well-established advantages for oily and acne-prone skin, as an anti-inflammatory, keratolytic and sebostatic agent (90). Willow bark is already rather commonly used by the skin care industry, cementing it in the understanding of consumers as a sign of efficacy in anti-acne and anti-oiliness products. While more research on the properties of willow bark itself, compared to pure salicylic acid, is necessary to draw accurate conclusions on actual efficacy against acne, the association of this extract with well-researched actives such as AHAs may not only prove to be a marketable feature, but also one that enhances product performance to some degree.

Apple extract was the other selected botanical ingredient. This extract has enjoyed increasing popularity in moisturizer formulations. According to suppliers' data, the extract has an exfoliating action, since apples are a natural source of AHAs (malic acid, for instance, derives its name from the Latin word for 'apple', and it contributes to the sourness in the fruit's taste) (122). The extract may also offer an anti-inflammatory, photoprotective and cytoprotective effect resulting from the presence of polyphenolic antioxidants (tannins, phenols, flavonoids, and anthocyanins) in this fruit (123–125). Apples are part of the myths and traditions of many cultures, including that of Lithuania, wherein they were used to represent the setting sun and are part of certain Christmas Eve traditions (126); as such, they fulfill the criteria of traditional significance and recognizability as part of Baltic nature.

The fragrance for the line was selected from the company's library of scents, based on guidelines from the Marketing and NPL direction. The briefing for this selection required a scent that would be less sweet and youthful than the former raspberry one, leaning into a more professional, herbal feeling, while not being instantly identifiable as deriving from any one plant in particular. The anonymously green, refreshing fragrance that was chosen to scent the line was one emulating the scent of lady's mantle (*Alchemilla vulgaris*).

2.4. Planned timeline of product development

Once the product concepts, active ingredients, and fragrance of the MAA line reformulation were decided upon, the formulation process was able to proceed in earnest. The initial step of new product development within the NPL — prior to the decision-making processes described above — is to prepare a descriptive product datasheet, and an accompanying projected timeline for each step of the line's development (figure 4).

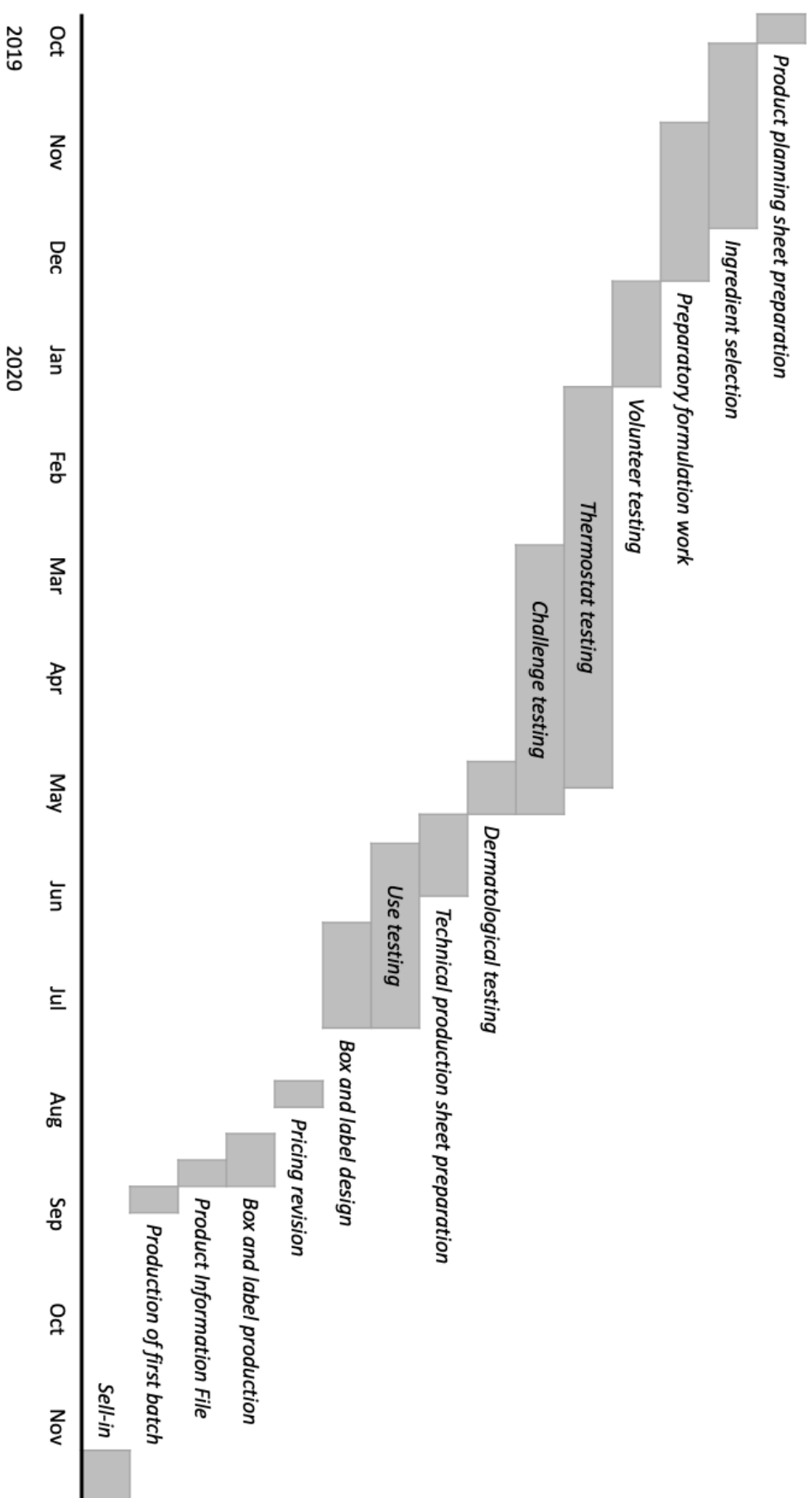


Figure 4: Projected timeline of product development of the Margarita Anti Acne line.

Once all four reformulated products of the MAA line were decided upon and the ingredients selected, formulation work began; although adjustments to the formulations still occurred as late in the development process as during the initial phases of stability testing, once a prototype version of all products was available, samples were prepared and sent out for volunteer testing. The feedback obtained from this testing informed the subsequent adjustments and consolidated the direction of the reformulation project.

This internship project accompanied the formulation process up to and including the preparation of samples for microbial challenge testing. Additional adjustments to the formulas herein presented as final may still occur as a result of the scaling-up process, when the first batches are produced on a full industrial scale, due to technical requirements and differences in the behavior of bulk raw materials. The following chapters will be dedicated to the exploration of the preparatory laboratory work, volunteer testing and subsequent formulation adjustments, stability testing and finalization of the MAA line reformulation.

2.5. Preliminary evaluation of the formulation prototypes

Prior to delving into the several versions of each MAA product, it is important to understand the methods by which feedback on the initial prototypes was obtained, and how the respective results were assessed. The standard procedure for preliminary testing of prototypes adopted by BLOK involves the distribution of product samples prepared within the NPL to a number of volunteers, alongside an informative leaflet detailing the product's characteristics and usage method. After a defined period of testing, email questionnaires created with Google Forms are then sent to participants to collect their feedback pertaining to the user experience, sensorial properties and effects on the skin of the product. The data from the questionnaires is used to fine-tune the formulation and assess interest in the products.

In the particular instance of the MAA line reformulation, thirty samples of each of the four prototype formulations were prepared in early December and sent out to the same number of volunteer participants inscribed in the NPL's mailing list (figure 5). Testing took place from mid-December until mid-January — a longer time frame than the usual volunteer testing carried out by the NPL, which lasts one to two weeks. This offered the advantage of allowing volunteers to become more familiar with the products and permitted any effects of the products' active ingredients on the skin to become more visible. Participants were also given a detailed informational sheet explaining the purpose and mode of use of the entire MAA line (table 3).

Table 3: Informative sheet for the volunteer testing of the prototype formulations.

Margarita Anti Acne: Cosmetic line for the care of acne-prone skin. Contains apple extract, a source of fruit acids, to attain a gentle exfoliating effect and antioxidant properties. Willow extract is a natural source of salicylic acid derivatives, to help reduce the appearance of pores and calm the skin. The acids contained in the products may, at first, cause tingling or redness, which usually subsides after a few days of use. If the sensations persist, it is recommended to interrupt the testing.		
<i>Ingredients</i>	<i>pH</i>	<i>Use instructions</i>
MARGARITA ANTI ACNE face wash with 0.8% lactic acid, apple and willow extracts		
Aqua, Glycerin, Coco-Glucoside, Cocamidopropyl Betaine, Sodium Cocoyl Glutamate, PEG/PPG-120/10-trimethylolpropane, Laureth-2, Propanediol, Glyceryl Oleate, Pyrus Malus (Apple) Fruit Extract, Salix Alba (Willow) Bark Extract, Lactic Acid, Allantoin, Parfum, Ethylhexylglycerin, Sodium Hydroxide.	5.25	Daily facial cleanser for the removal of built-up sebum and grime. Avoid contact with eyes.
MARGARITA ANTI ACNE exfoliating toner with 2.4% lactic acid, 1.4% glycolic acid, apple and willow extracts		
Aqua, Glycerin, Lactic Acid, Sodium Hydroxide, Glycolic Acid, Propanediol, Pyrus Malus (Apple) Fruit Extract, Salix Alba (Willow) Bark Extract, Betaine, Polysorbate 20, Allantoin, Ethylhexylglycerin, Potassium Alum, Parfum	5.50	Active cleansing facial toner for twice-daily use following the Margarita facial cleanser. Soak a cotton pad in the toner and apply evenly on blemish-prone skin. Can be also used on the body (back and shoulder area). Avoid contact with eyes.
MARGARITA ANTI ACNE hydrating gel-cream with 0.24% lactic acid, apple and willow extracts		
Aqua, Dicaprylyl Ether, Hydrogenated Polydecene, Glycerin, Sodium Acrylates Copolymer, Lecithin, Propanediol, Undecane, Tridecane, Betaine, Pyrus Malus (Apple) Fruit Extract, Salix Alba (Willow) Bark Extract, Tocopheryl Acetate, Lactic Acid, Allantoin, Ethylhexylglycerin, Sodium Hydroxide, Parfum	5.00	Gentle moisturizing cream gel for acne-prone skin. Can be used in the morning and evening, after applying Margarita Anti Acne cleanser and tonic.
MARGARITA ANTI ACNE cleansing facial mask-scrub with 1.2% lactic acid, 0.7% glycolic acid, apple and willow extract		
Aqua, Cellulose, Glycerin, Propanediol, Lactic Acid, Sodium Acrylates Copolymer, Lecithin, Sodium Hydroxide, Cellulose Gum, Glycolic Acid, Pyrus Malus (Apple) Fruit Extract, Salix Alba (Willow) Bark Extract, Xanthan Gum, Ethylhexylglycerin, Parfum	4.50	1. As a mask-scrub: use 1-2 times a week. The package contains enough product for 3 applications. Spread over dry, clean skin with circular motions, and massage gently until small clumps of the product start forming, for up to 5 minutes. Rinse with lukewarm water and follow with the Margarita Anti Acne moisturizing gel-cream. 2. As a spot treatment: to minimize single pimples, apply a small amount of the product directly on the blemish and leave on for 5-10 minutes. Remove the dried-up film by peeling it off. Rinsing is not necessary.



Figure 5: Prototype samples of each of the four products of the renewed Margarita Anti Acne line prepared for volunteer testing.

At the end of the testing period, participants were given two weeks to complete the questionnaires sent via email (transcribed in Annex 1). These questionnaires included an evaluation of the skin type and concerns of each participant, in order to better understand how the renewed MAA might affect the target skin type (acne-prone and tendentially normal to oily or combination), as well as other skin types such as more sensitive individuals, for whom the increased acid concentrations might give rise to reactions. The prior experience of each participant with exfoliating acids was also given consideration, as it affects their skin's response to the products: a seasoned user of AHA-based skin care may find the exfoliation offered by the MAA line rather gentle, whereas a complete beginner may experience tingling and slight redness upon the initial applications.

Beside individual skin characteristics and skin care routine habits, the participants were also questioned regarding their opinion on the product's sensorial properties (consistency, scent type and intensity, speed of absorption, existence of any residue, and after-feel). The irritation potential of the products was evaluated based on whether they caused any tightness, dryness, redness, tingling or burning. Furthermore, specific effects of each product, such as the moisturizing ability of the gel-cream, pore size-reducing effects of the toner, and any skin softening resulting from the use of the *gommage*. Participants were also inquired about their familiarity with the original MAA line, and, if they had previously used the brand's anti-acne products, how their experience with the new prototypes compared with the originals. Finally, the volunteers were asked to give each product an overall rating, to indicate whether they thought the tested version was ready for sale, and to add any comments or opinions they might deem relevant.

The data from the volunteers that completed the questionnaires were compiled and treated using Google Forms and Excel software, and will be presented and discussed in later sections of this work, alongside each product's formulations.

These results are by no means a rigorous evaluation of the effectiveness of the MAA products; rather, the volunteer testing period is intended as a first assessment of the viability of the line, in terms of its surface-level characteristics (sensorial properties, in-use performance, and comparison to the previous versions). This testing method suffers from several shortcomings — to name a few, out of 30 volunteers who received product prototypes, 29 participated in the survey, and only 24 answered all four questionnaires. Their self-assessment carries inherent biases and inaccuracies (127). Self-selection bias, for instance, is present; most of the volunteers who completed all the questionnaires were female (87.5%), and only 41.4% of all participants reported suffering from acne.

These shortcomings do not, however, negate the usefulness of collecting this feedback; at an intermediate stage of the formulation process, the goal of validating the direction chosen for the reformulated line was fulfilled, from the perspective of the voice of the consumer within the framework of Quality Function Deployment (QFD) (128). In later stages that fall beyond the scope of this work, after the adjustments made to the product formulas due to the feedback and stability data, further assessment (in-use and dermatological testing) will be carried out by external, certified entities, resorting to panels of trained experts and carefully selected groups of volunteers to reduce bias and better determine the effectiveness of the anti-acne products.

In future instances, this step of the product development and the process as a whole might benefit from a better integration of the Total Quality Management philosophy, allowing for a greater input of the NPL in the establishment of objectives. This would afford a better representation of the voice of the company in the innovation process, and establish the basis for questionnaires that provide a clearer picture of the voice of the consumer, which can be translated into technical requirements for a more structured approach to product development, such as QFD (128).

3. REFORMULATION OF THE FACIAL CLEANSER

3.1. Original formulation of the Margarita Anti Acne Facial Cleanser

The facial cleanser released within the original MAA line was a water-based gel formulation relying on the thickening power of coco-glucoside and glyceryl oleate. Beyond the mild, non-ionic coco-glucoside, other surfactants were employed, namely sodium cocoamphoacetate, lauryl glucoside, sodium cocoyl glutamate, and sodium lauryl glucose carboxylate. The product featured salicylic acid, for its ability to combat blackheads and provide an exfoliating effect, and the line's distinctive scent of grapefruit and raspberry due to the inclusion of these two plant extracts in the formulation. A full breakdown of the composition of the original MAA facial cleanser is presented below on table 4.

Table 4: Composition and description of product requirements for the Margarita Anti Acne facial cleanser.

Raw materials, according to INCI name	Function	% (mass)
Aqua	Solvent	to 100%
Sodium Cocoamphoacetate, Glycerin, Lauryl Glucoside, Sodium Cocoyl Glutamate, Sodium Lauryl Glucose Carboxylate	Surfactant	40.00
Coco-Glucoside, Glyceryl Oleate	Surfactant, refatting agent, thickener	4.00
Propylene Glycol, Aqua, Citrus Grandis (Grapefruit) Fruit Extract	Botanical active ingredient	1.00
Citric Acid	pH adjuster	0.40 – 0.99
Aqua, Sodium Benzoate, Potassium Sorbate ¹	Preservative	0.50 – 0.80
Salicylic acid	Active ingredient	0.50
Parfum	Scent	0.25
Propylene Glycol, Aqua, Rubus Idaeus (Raspberry) Fruit Extract	Botanical active ingredient	1.00
Product Technical Requirements		
<i>Appearance</i>	Transparent viscous mass	
<i>Color</i>	Yellow	
<i>Scent</i>	Raspberry	
<i>pH</i>	3.5 – 6.5	
<i>Maximum total microorganism colony-forming units (CFUs) in 1 g of product</i>	1000	
<i>Amount of product, out of 1 g, not containing Pseudomonas aeruginosa, Staphylococcus aureus, Candida albicans, or Escherichia coli</i>	1 g	
<i>Expiry date</i>	18 months, from date of manufacture	

Notes:

¹ At a mixture concentration of 0.8%: Sodium Benzoate - 0.16%, Potassium Sorbate - 0.28%

The percentages in mass presented in this table, and in the equivalent ones concerning other MAA products (originals and reformulations), correspond to the total amount of the raw materials, designated by their International Nomenclature of Cosmetic Ingredients (INCI) names, and not to the pure substances. The cleanser was commercialized in 150 ml plastic flip-top bottles. It was intended for twice-daily use, by lathering up the product with the hands and applying on damp skin, then rinsing off with water. The unit price for the end consumer was of 4.49 €.

3.2. Objectives of the reformulation of the facial cleanser

The product development proposal, elaborated by the Marketing department, outlined the following as desired attributes to be achieved by the reformulated MAA cleanser:

- *The product should cleanse the skin gently and deeply;*
- *It should reduce skin shine caused by excess sebum production;*
- *It should give the skin a mattified look;*
- *It should regulate sebum secretion;*
- *It should reduce the appearance of pores;*
- *It should provide antioxidant benefits;*
- *It should provide gentle exfoliation.*

Furthermore, the proposal document indicates that the cleanser should be suitable for twice-daily washing, at morning and night, of the face, neck and shoulders.

The reformulation of the MAA line, as previously explored, was chiefly intended to renew the line under a less juvenile, more professional feel, with actives that correlated more closely with Baltic nature, and with formulations that better reflected the advances in technology as well as the changes in consumer preferences. The facial cleanser was, therefore, initially proposed to be replaced by a liquid cleanser packaged with a self-foaming pump, so as to introduce a novel product type into the lineup. However, the gel cleanser originally performed very well in sales and received positive feedback from consumers, and as such it was ultimately decided that the formulation type should remain broadly the same, albeit with changes to its surfactants and preservative system, so as to ensure mildness and reduce its irritation potential. The fragrance and botanical extracts would also be replaced by those that are characteristic of the renewed MAA line (the herbal scent of lady's mantle, and apple fruit and white willow bark extracts, respectively). Whereas the original

contained salicylic acid, the reformulation would instead feature AHAs, particularly lactic and glycolic acids, to help provide a slight chemical exfoliation.

It should be noted that some of the desired benefits proposed by the Marketing department, such as the ability to provide antioxidant benefits or to regulate sebum production, would need to be validated by specialized testing in order to be presented as claims. The apple extract was included partly due to its potential antioxidant activity, but this cannot be extrapolated to the final product without substantiation. The experimental design and testing fall outside the scope of the present reformulation project. Moreover, the ability to regulate sebum production blurs the lines between drug and cosmetic: cosmetic products must not claim the ability to alter the structure or function of the skin, as such an effect falls outside of their definition (120). As previously discussed, clearer communication between the Marketing department and the NPL could avoid these issues, by providing better insight on the voice of the consumer and the voice of the company (128).

3.3. Tester feedback results and subsequent changes to the cleanser formulation

The responses to the questionnaire pertaining to the cleanser prototype (also presented in Annex I) were reviewed so as to understand what improvements to the formulation might be needed; these responses are summarized in table 5.

Table 5: Volunteer feedback from the questionnaire regarding the Margarita Anti Acne facial cleanser.

Questionnaire criteria		Testers who agree (%)	Number of answers
<i>Pleasantness of use</i>	Enjoyable consistency	93	28
	Adequate thickness	82	28
	Scent pleasantness	71	28
	Scent intensity	64	28
<i>Perceived effectiveness</i>	Cleansing effect	96	28
<i>Presence of side effects</i>	Initial tingling/burning sensation	11	28
	Persistent tingling/burning sensation	0	28
	Initial redness	21	28
	Persistent redness	0	28
	Dryness/tightness	24	25
<i>Perceived added value</i>	Improvement over original	80	5
	Suitability for market	93	28

As these questionnaires were conducted in an informal manner, according to the standard procedure of the company, the resulting feedback was of diverse nature. Certain questions were qualitative in scope, and others sought to rate the satisfaction of volunteers

with specific properties on a scale from 1 to 7, wherein, according to standard procedure at BLOK, an average score of 5 or above is satisfactory

In table 5, the percentage of testers that agreed with specific aspects of the product, or rated them 5 or above, is indicated; testers who were unable to respond to certain questions were not included in the percentage calculation. In total, 28 participants responded to the questionnaire. The feedback received was generally positive, with great satisfaction towards the product's consistency and its ability to cleanse the skin effectively. Although some testers experienced tingling or burning sensations and redness upon the first few uses (a common occurrence when initiating the use of exfoliating acids such as the ones contained in the MAA line) (117), these effects subsided after repeated use and did not cause any of the participants to discontinue the testing. The scent chosen for the line proved to be polarizing, with mainly positive ratings but a few very strong negative reviews. Thirty-six percent of the participants were dissatisfied with the scent intensity, however, with the general opinion being that it was too weak. Taking this into account, the amount of fragrance was increased in later versions of the formulation.

Only five of the respondents had previous experience with the original MAA line, but all but one of these reported enjoying the reformulated cleanser above the original one. The vast majority (93%) of all respondents considered the product ready for sale as is, and the average rating of the product overall was of 5.7 (figure 6).

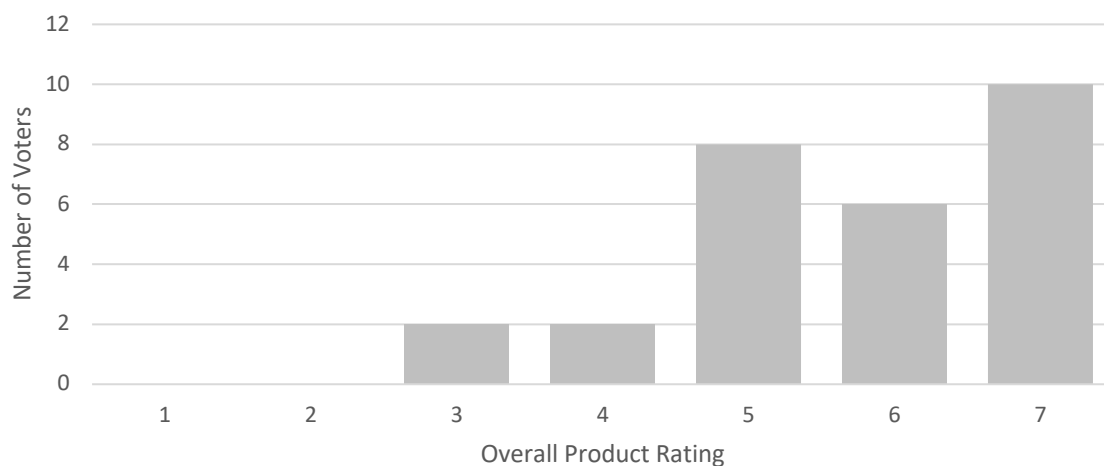


Figure 6: Rating distribution of the overall satisfaction with the prototype Margarita Anti Acne cleanser formulation.

The questionnaires included a section where volunteers may choose to leave a comment sharing their thoughts on the products. As with most of the line, a good portion of this feedback pertained to the choice of scent and its intensity, which seemed to be polarizing, with one tester likening it to “dishwasher detergent”; others enjoyed it, describing

it as a “delicate scent”. Regarding the effectiveness of the product, one user stated that their “pores were minimized, and areas with many blackheads cleared”; another “really liked the thicker consistency and the fact that the skin does not feel dehydrated at all after use”, stating that it was becoming “a new favorite”. However, testers’ opinions were split on the matter of consistency: one mentioned that they “would like more foam or a thicker consistency”, whereas others deemed it excessively thick.

3.4. Challenges of the reformulation process of the facial cleanser

Given the objective of creating a cleanser that is both very effective at removing dirt and yet not overly stripping to the skin, striking the delicate balance between surfactant potency and mildness proved challenging. Additionally, obtaining an adequately thick consistency for use with the planned packaging (a flip-top plastic bottle identical to that of the original product) was also a point of experimentation through trial and error.

Initially, the formulation base and surfactant systems were adapted from existing Margarita products (a children’s shampoo and an allergy-certified hair and body wash). However, the thickener system based on xanthan gum and the surfactants themselves did not provide a sufficiently consistent product, especially when the surfactants were decreased to reduce their stripping effect. Rather than opting for a salt-thickened surfactant mixture, new prototypes were created with a commercially available PEG/PPG-120/10 Trimethylolpropane Trioleate and Laureth-2 mixture, a thickening agent intended for use in formulations that contain low to null concentrations of sulfate surfactants. It provides gradual thickening over a period of a couple of hours, without requiring the addition of any salt or pH adjuster, and it tolerates the incorporation of acids. The product required the maximum concentration of this thickener recommended by the supplier (2%), at which the resulting gel had a satisfying consistency, a clear appearance, and a mild foaming effect (figure 7).



Figure 7: Appearance of the reformulated Margarita Anti Acne gel cleanser.

3.5. Formulation of the renewed facial cleanser

The reformulated version of the MAA facial gel cleanser is detailed below within table 6, alongside its preparation method. The version herein presented was the last one produced during the project, and although it is mostly accurate to the final product, some adjustments may yet be necessary as further testing data is received.

Table 6: Formulation of the renewed Margarita Anti Acne facial gel cleanser.

Raw materials (INCI)	Function	% (mass)
Aqua	Solvent	to 100
Allantoin	Moisturizing agent	0.20
Glycerin	Humectant	10.00
Sodium Cocoyl Glutamate	Surfactant (anionic)	5.00
Coco-Glucoside	Surfactant (non-ionic)	10.00
Coco-Glucoside, Glyceryl Oleate	Lipid layer enhancer, viscosity modifier	2.00
Cocamidopropyl Betaine	Surfactant (amphoteric)	9.00
Lactic Acid, 80%	Active ingredient, exfoliating acid	1.00
Sodium Hydroxide	pH adjuster	0.03
Aqua, Glycerin, Salix Alba (Willow) Bark Extract, Sodium Benzoate, Potassium Sorbate	Botanical active ingredient	0.50
Aqua, Glycerin, Pyrus Malus (Apple) Fruit Extract, Sodium Benzoate, Potassium Sorbate	Botanical active ingredient	0.50
Parfum	Fragrance	0.30
Propanediol	Preservative	1.35
Ethylhexylglycerin	Preservative	0.15
PEG/PPG-120/10 Trimethylolpropane Trioleate, Laureth-2	Thickener	2.00

Product Technical Requirements

Cost per 100 g	0.13 €
Appearance	Transparent gel with a very slight opalescence
Scent	Lady's Mantle (Herbal)
pH	4.5 – 5.5

Preparation:

1. Dissolve the allantoin powder in the water, using heat if necessary.
2. Add the surfactants, glycerin and the lipid layer enhancer and heat under stirring until dissolved (up to 60 – 70 °C).
3. Remove from heat and add the betaine (after the stirring is decreased to avoid excess foaming).
4. Let the mixture cool down to under 45 °C.
5. Add the lactic acid and sodium hydroxide; once both are stirred in, add the plant extracts, perfume, and preservatives.
6. Add the thickener, stir and allow the gel to gain viscosity over 1h or more, if possible, to ensure the full thickness has been achieved.

4. REFORMULATION OF THE EXFOLIATING TONER

4.1. Original formulation of the Margarita Anti Acne exfoliating toner

The toner included in the original MAA line relied on AHA-based exfoliation, through the presence of glycolic acid, to combat the hyperkeratosis processes that underlie acne formation. Additionally, potassium alum was included to provide an astringent effect that is frequently sought by individuals with oily skin. Glycerin and betaine were included to provide a hydrating effect. The detailed composition of the water-based toner is described in table 7.

Table 7: Composition and description of product requirements for the Margarita Anti Acne exfoliating toner.

Raw materials, according to INCI name	Function	% (mass)
Aqua	Solvent	to 100%
Glycolic acid, 70%	Active ingredient, exfoliating acid	5.00
Glycerin	Humectant	3.00
Betaine	Humectant	1.00
Aqua, Propylene Glycol, Citrus Grandis (Grapefruit) Fruit Extract	Botanical active ingredient	1.00
Aqua, Sodium Benzoate, Potassium Sorbate ¹	Preservative	0.50
Propylene Glycol, Aqua, Rubus Idaeus (Raspberry) Fruit Extract	Botanical active ingredient	1.00
PEG-40 Hydrogenated Castor Oil	Solubilizer	0.25
Potassium Alum	Active ingredient, astringent	0.10
Sodium Hydroxide	pH adjuster	0.90
Disodium EDTA	Chelating agent	0.05
Parfum	Scent	0.10
Product Technical Requirements		
Appearance	Clear liquid (sedimentation possible during storage)	
Color	Clear	
Scent	Raspberry	
pH	3.5 – 4.5	
Maximum total microorganism colony-forming units (CFUs) in 1 g of product	1000	
Amount of product, out of 1 g, not containing <i>Pseudomonas aeruginosa</i> , <i>Staphylococcus aureus</i> , <i>Candida albicans</i> , or <i>Escherichia coli</i>	1 g	
Expiry date	18 months, from date of manufacture	

Notes:

¹ At a mixture concentration of 0.5%: Sodium Benzoate - 0.10%, Potassium Sorbate - 0.18%

The toner was intended for use on clean and dry skin, applied to the face with a cotton round or with the hands. It was available in 150 ml flip-top plastic bottles, at a unit price of 4.99 € for the end consumer.

4.2. Objectives of the reformulation of the exfoliating toner

The original MAA toner, as the cleanser, performed well in sales; however, some consumer feedback sourced from retailer websites and online cosmetic databases mentioned that the toner caused some redness and, in some cases, a burning sensation after application. Therefore, although the reformulated MAA toner still follows a similar structure to the original given the type of water-based product it is, efforts were made to reduce its irritation potential where possible.

The requests from the Marketing department for this product were the following:

- *The toner should brighten and revitalize facial skin;*
- *It should regulate sebum secretion, thus reducing excessive gloss;*
- *It should reduce the appearance of pores;*
- *It should gently cleanse the skin;*
- *It should contribute to a radiant complexion;*
- *It should provide antioxidant benefits;*
- *It should provide gentle exfoliation.*

The product should also be suitable for skin damaged by acne, on the face, neck and back. Once again, claims such as antioxidant properties of the finished product or its ability to regulate sebum production fall outside the scope of this work, and, in the case of the latter, outside of the scope of the regulatory definition of a cosmetic product (120).

The desired effect of a radiant, revitalized and brightened complexion was sought by including AHAs as chemical exfoliants: whereas the original toner contained only glycolic acid, the reformulation would feature lactic acid as well, and a higher total concentration of AHAs. The same astringent would be kept in the formula to achieve a reduction in the apparent size of the pores.

Beyond these, the main changes to the formulation were the same that were applied to the entire line: the fragrance, the featured botanical extracts, and the preservative system.

4.3. Tester feedback results and subsequent changes to the toner

Following the same criteria for data treatment described in the previous chapter, the feedback from volunteer testers received in the toner questionnaire is presented below on table 8. In total, 26 of the testers completed the questionnaire, although some were unable to respond to certain questions, and were excluded from the percentage calculation in those questions.

Table 8: Volunteer feedback from the questionnaire regarding the MAA exfoliating toner.

Questionnaire criteria		Testers who agree (%)	Number of answers
<i>Pleasantness of use</i>	Scent pleasantness	81	26
	Scent intensity	81	26
	Fast absorption	85	26
	Tolerability of the acid odor	88	25
<i>Perceived effectiveness</i>	Perceived pore tightening	46	26
<i>Presence of side effects</i>	Initial tingling/burning sensation	21	24
	Persistent tingling/burning sensation	8	24
	Initial redness	12	25
	Persistent redness	12	25
	Sticky residue	33	24
<i>Perceived added value</i>	Improvement over original	75	4
	Suitability for market	81	26

Most testers found the scent and its intensity agreeable (81%), although the majority of those who disagreed considered it too strong. The added fragrance was insufficient to wholly mask the characteristic odor of the lactic and glycolic acids, but most testers (88%) found that odor to be tolerable regardless. As such, no changes were made to the scent of the toner from its prototype formulation.

Only 46% of testers reported a perceived pore tightening effect; while pores do not contract or expand in the same manner as sphincters, contrary to common belief, their appearance may be diminished by the use of active ingredients that create a plump and hydrated look of the skin, protect it from photoaging, help control excess sebum, or offer astringent benefits (129). These improvements, however, tend to be very slight and may require prolonged use to become apparent.

The higher concentrations of AHAs in this product, compared to the rest of the line, caused three of the 26 testers to discontinue its use, as they experienced tingling and/or redness that persisted beyond the first few uses. An additional 21% experienced a tingling sensation during the first few uses, which eventually disappeared, and 12% reported initial redness that also subsided with repeated use. It is important to note that 19% of all testers

self-described their skin as sensitive, and that 23% had no prior experience with exfoliating acids, which may have resulted in an exacerbated reaction to the higher concentration of AHAs within the toner. Nevertheless, the pH of the toner was adjusted to be slightly higher in subsequent formulations, although the balancing of its acidity levels proved to be challenging.

Despite these drawbacks, out of the 4 users who had prior experience with the original MAA toner, 3 of them preferred the renewed version, and 81% of all testers considered this version ready for sale as is. The overall score distribution, presented below on figure 8, averaged at 5.5, an acceptable value by BIOK's internal standards.

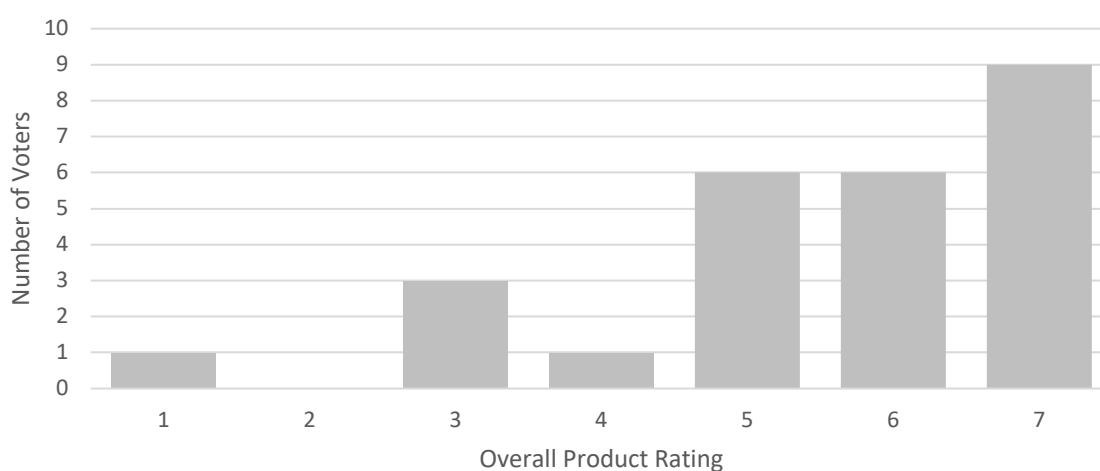


Figure 8: Rating distribution of the overall satisfaction with the prototype Margarita Anti Acne toner formulation.

Three volunteers commented that the stickiness of the toner was an issue to be solved; one also stated that they “did not like the smell, and the effect was not noticeable or pleasant enough that [they] could ignore it”. Another considered it a “very gentle” product, especially when compared with the original, which “leaves the skin red after use (...), dehydrates the skin and makes it tingle”; however, they expressed concerns that “the concentration of the toner is too low, because it has no effect on skin accustomed to acids”. On the other hand, another tester reported that their skin is not sensitive or prone to allergic reactions and “even tolerates [a 10% glycolic acid cleanser] very well”, but they experienced localized redness on the cheek area that caused them to discontinue use of the toner.

Despite these mixed opinions, there were several positive comments as well. One volunteer considered it “a great toner” that “tightens and refreshes the skin” and mentioned that they “really liked the aroma — fresh and unobtrusive”. It was stated that the toner “quickly absorbed into the skin”, and two testers mentioned that, despite usually not being fond of using toners, they “really liked this one”.

4.4. Challenges of the reformulation process of the exfoliating toner

The main issue encountered during the formulation process of the toner was the adjustment of its pH so as to include an increased concentration of acids compared to the original version, but without allowing the pH level to drop to an acidity that could cause irritation and sensitivity.

The original formulation relied simply on sodium hydroxide to adjust its pH and partially neutralize the acids, making it possible to maintain a pH level of 3.5 to 4.5. However, the reformulation was required to both feature an increased concentration of acids, for marketability purposes, and a decreased irritation potential. It featured 2.4% lactic acid and 1.4% glycolic acid, which required about 1.7% NaOH to attain the pH levels of 4.5 to 5.5 (a higher value compared to the original, intended to more closely resemble the skin's pH and decrease the irritation potential of the toner). Neutralizing the AHAs with NaOH yields the respective salts (sodium lactate and sodium glycolate), which still offer benefits as buffers, humectants and keratolytic agents. One difficulty resulting from this neutralization reaction was that the turning point of the acid-base curve was very rapid, meaning that small variations in the amount of NaOH added resulted in significant variations of pH.

The other main challenge that was tackled during the reformulation of the toner was its stickiness and tendency to foam, as observed in the initial prototypes; this was effectively addressed by swapping out the emulsifier (Polysorbate 20, initially) for PEG-40 Hydrogenated Castor Oil. Its concentration was also adjusted to allow the integration of ethylhexylglycerin as part of the preservative system without causing cloudiness in the liquid (figure 9).



Figure 9: Appearance of the reformulated Margarita Anti Acne exfoliating toner.

4.5. Formulation of the renewed facial toner

Table 9 contains the reformulated version of the MAA exfoliating facial toner in full, reflecting the previously mentioned adjustments to its composition, and its preparation method. The toner was the cheapest of all four reformulated MAA products, in terms of raw material costs (0.08 € per 100 g in total, well within the maximum budget of 0.25 € /100 g), due to the great majority of its mass being comprised of water.

Table 9: Formulation of the renewed Margarita Anti Acne exfoliating facial toner.

Raw materials (INCI)	Function	% (mass)
Aqua	Solvent	to 100
Potassium Alum	Astringent	0.10
Allantoin	Moisturizing agent	0.20
Betaine	Moisturizing agent	1.00
Glycerin	Humectant	1.50
Glycolic Acid, 70%	Active ingredient, exfoliating acid	2.00
Lactic Acid, 80%	Active ingredient, exfoliating acid	3.00
Sodium Hydroxide	pH adjuster	1.69
Aqua, Glycerin, Salix Alba (Willow) Bark Extract, Sodium Benzoate, Potassium Sorbate	Botanical active ingredient	0.50
Aqua, Glycerin, Pyrus Malus (Apple) Fruit Extract, Sodium Benzoate, Potassium Sorbate	Botanical active ingredient	0.50
PEG-40 Hydrogenated Castor Oil	Emulsifier	0.45
Parfum	Fragrance	0.05
Propanediol	Preservative	1.35
Ethylhexylglycerin	Preservative	0.15

Product Technical Requirements

<i>Cost per 100 g</i>	0.08 €
<i>Appearance</i>	Transparent liquid with a yellowish tint
<i>Scent</i>	Lady's Mantle (Herbal)
<i>pH</i>	3.8 – 5.5

Preparation:

1. Dissolve the potassium alum and allantoin in small amounts of water each, using heat if needed.
2. Add to the rest of the water, add the glycerin and betaine and stir until all are dissolved.
3. Add the acids and the sodium hydroxide.
4. Add the plant extracts.
5. Mix perfume with the emulsifier and add to the mixture under stirring.
6. Add the preservatives under stirring to ensure proper dispersion of the ethylhexylglycerin.

5. REFORMULATION OF THE MOISTURIZING GEL-CREAM

5.1. Original formulation of the Margarita Anti Acne Moisturizing Gel-Cream

The moisturizing step of the original MAA routine was provided by a gel-cream product. Its composition and characteristics are described in table 10.

Table 10: Composition and description of product requirements for the Margarita Anti Acne moisturizing gel-cream.

Raw materials, according to INCI name	Function	% (mass)
Aqua	Solvent	to 100
Tapioca Starch Polymethylsilsesquioxane	Active ingredient, oil absorber	5.00
Cetearyl Alcohol	Thickener	2.00
Cyclopentasiloxane	Emollient	2.00
Glycerin	Humectant	2.00
Sodium Polyacrylate	Thickener	2.10
Caprylic/Capric Triglyceride	Emollient	1.00
Isopropyl Myristate	Emollient	1.00
Salicylic Acid	Active ingredient	1.00
Parfum	Scent	0.20
Sodium Stearoyl Glutamate	Emulsifier	0.25
Aqua, Propylene Glycol, Citrus Grandis (Grapefruit) Fruit Extract	Botanical active ingredient	1.00
Aqua, Propylene Glycol, Rubus Idaeus (Raspberry) Fruit Extract	Botanical active ingredient	1.00
Sodium Benzoate, Potassium Sorbate	Preservative	0.80
Tocopheryl Acetate	Antioxidant	0.5
Sodium Hyaluronate	Humectant	0.01
Sodium Hydroxide	pH adjuster	0.00 – 0.02
Product Technical Requirements		
<i>Appearance</i>	Solid cream with fine particle inclusions	
<i>Color</i>	White (gel)	
<i>Thermal stability</i>	Stable	
<i>Emulsion stability</i>	Stable	
<i>Scent</i>	Raspberry	
<i>pH</i>	3.5 – 5.5	
<i>Maximum total microorganism colony-forming units (CFUs) in 1 g of product</i>	1000	
<i>Amount of product, out of 1 g, not containing Pseudomonas aeruginosa, Staphylococcus aureus, Candida albicans, or Escherichia coli</i>	1 g	
<i>Expiry date</i>	18 months, from date of manufacture	

Notes:

¹ At a mixture concentration of 0.8%: Sodium Benzoate - 0.16%, Potassium Sorbate - 0.28%

The moisturizing gel-cream was intended to create a mattifying finish, and to this end the formulation included a tapioca starch derivative with oil absorbing properties. The moisturizing properties of the cream derived from the presence of medium- to lightweight emollients (cyclopentasiloxane, caprylic/capric triglyceride, isopropyl myristate) and humectants (glycerin and sodium hyaluronate), avoiding heavier oil-based ingredients and occlusives with comedogenic potential. Salicylic acid was included at a concentration of 1% as the main anti-acne active ingredient within this product.

The gel-cream was packaged within a soft plastic flip-cap tube with a capacity of 50 ml, at a unit price of 5.99 €.

5.2. Objectives of the reformulation of the moisturizing gel-cream

Individuals with acne tend to perceive their own skin as very oily and therefore can offer resistance to incorporating moisturizers into their skin care routine, in fear of aggravating this excess oiliness. As such, marketing a moisturizer specifically for this target demographic and formulating it so that it is pleasant and effective to satisfy consumer demands implies specific requirements to be taken into consideration.

The key points presented by the Marketing Department proposal document were the following:

- *The gel-cream should moisturize and soften facial skin;*
- *It should soothe irritated skin and reduce skin discomfort;*
- *It should mattify skin, reducing shine caused by excessive sebum secretion;*
- *It should restore the skin's natural lipid barrier;*
- *It should contribute to the prevention of new breakouts;*
- *It should reduce the appearance of pores;*
- *It should provide gentle exfoliation.*

The moisturizer should be suitable for daily use on acne-damaged facial skin, and it should be classifiable as noncomedogenic. Given the lack of defined regulations on what constitutes a noncomedogenic product, the working standards adopted for the reformulation product were to avoid ingredients which have been implicated in research showing a potential to trigger comedogenesis.

To achieve a lightweight texture and an adequate reparation of the skin's lipid barrier, which may become compromised in instances of irritation (130), the composition of the reformulated moisturizer featured humectants and highly spreadable emollients, rather

than a richer oil phase featuring occlusives. The formulation did still include an oil phase, but it was kept to a minimal amount, and the bulk of the ingredients, including the thickening agents, were included in the aqueous phase.

To contribute to the desired mattifying action, prototypes containing starch (as in the original product) were prepared, but eventually discarded due to the technical challenges its incorporation into the product mass posed, as well as due to the overall cost limit. Lactic acid, the milder AHA when compared to glycolic acid due to a larger molecular size (131), was also included at a very low percentage.

5.3. Tester feedback results and subsequent changes to the gel-cream

The questionnaire about the moisturizing gel-cream had a total of 26 respondents, whose feedback is presented below on table 11 according to the same data treatment method utilized in previous chapters.

Table 11: Volunteer feedback from the questionnaire regarding the Margarita Anti Acne moisturizing gel-cream.

Questionnaire criteria		Testers who agree (%)	Number of answers
<i>Pleasantness of use</i>	Enjoyable consistency	88	26
	Adequate thickness	65	26
	Fast absorption	85	26
	Scent pleasantness	77	26
	Scent intensity	77	26
<i>Perceived effectiveness</i>	Moisturizing effect	81	26
	Refreshing effect	69	16
	Mattifying effect	62	21
<i>Presence of side effects</i>	Initial tingling/burning sensation	12	26
	Persistent tingling/burning sensation	0	26
	Initial redness	16	25
	Persistent redness	0	25
	Skin shine/gloss	50	26
	Sticky residue	12	24
<i>Perceived added value</i>	Improvement over original	67	9
	Suitability for market	88	26

81% of all testers agreed that the product succeeded in its main purpose, which was to moisturize the skin; they also considered that it did so while being absorbed quickly (85%) and only 12% felt that it left a sticky residue. The other desired characteristics — a refreshing feeling and a mattifying effect — were reported by 69% and 62% of users, respectively. 50% considered that the product imparted a glossy or shiny look to the skin, either immediately upon application or, in some cases, after a couple hours of wear.

Considering that the formulation did not include any mattifying ingredients (such as the tapioca starch derivative in the original MAA moisturizer) in the end, this is not a surprising result.

The product's sensorial properties were generally considered satisfactory, although the consensus was that its thickness was insufficient. As with all other products in the line, a few users reported a strong dislike of the chosen fragrance, but overall it was well accepted; those who reported a dissatisfaction with its intensity were evenly split between considering it too strong and too weak, so it was decided that it should remain as is.

A few volunteers reported initial tingling sensations (12%) and/or redness (16%), which subsided with repeated use, and in no cases led to the interruption of use.

Nine of the volunteers who responded to the questionnaire had experience with using the original MAA moisturizer; out of these, 67% preferred the reformulated gel-cream. Most respondents (88%) considered the product ready for sale as is. The overall satisfaction with the gel-cream is presented below on figure 10, with the average rating being of 5.6.

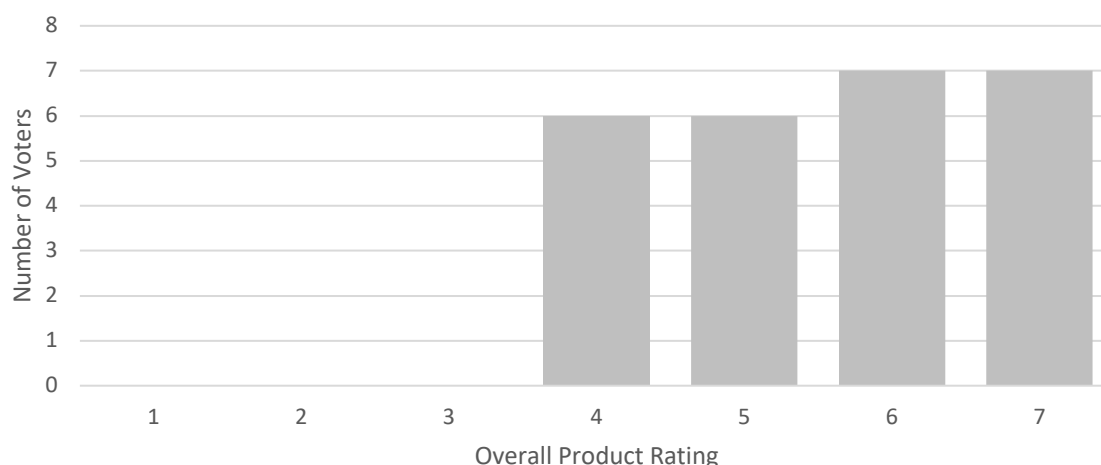


Figure 10: Rating distribution of the overall satisfaction with the prototype Margarita Anti Acne gel-cream formulation.

The comments from the testers tended to be quite positive, with one volunteer stating that the gel-cream left a “very pleasant feeling after use”, making their skin feel “comfortable” and “hydrated”, and stating that the “new version has become irreplaceable” for them. Another stated that the gel-cream “perfectly moisturizes the skin”, even after the application of potentially irritating products.

Negative feedback mentioned the cream's consistency being “too thin”; some users had issues with the scent, with one classifying it as “annoying” and another stating that “there was no scent of apple or willow at all” (the fruit and bark extracts used had almost no

scent to them; the expectations of consumers might be misled by marketing that places emphasis on these ingredients).

One volunteer also expressed concerns over sun safety, stating that “as a day cream, it is unsuitable, as it has no SPF and, due to the acids, it would cause hyperpigmentation spots after sun exposure”. While the product was created without any intention to replace the use of sunscreen, and without UV filters so that it could be used both during daytime (followed by adequate sun protection) and in the evening, this hints at a potential avenue for expanding the MAA line so that it can offer a complete skin care routine.

5.4. Challenges of the reformulation process of the moisturizing gel-cream

Achieving a satisfactory thickness of the product proved to be the main challenge of the reformulation of the gel-cream. The renewed formulation was not based on any pre-existing product in the BLOK portfolio, besides the original MAA moisturizer. This required an exploratory period of prototype creation, attempting to use different thickeners to adjust the consistency of the gel-cream.

One of the thickeners tested was composed of Polyacrylates Crosspolymer-11 (thickener A), which afforded a good consistency; however, it was costly when compared to the alternative offered by another of BLOK’s suppliers, a mixture of Sodium Acrylates Copolymer and Lecithin (thickener B). Given that the reformulation project as a whole was conducted on a budget of 0.25€ per 100 g of each product, and that this budget was overshoot in one other product, the choice of emulsifier was therefore settled by the lower cost of thickener B. Another advantage of thickener B, particularly when used with the highly spreadable, liquid emollients selected, is that it serves as a cold-process emulsifier, meaning there is no need to heat the oil and water phases prior to mixing in order to create a stable emulsion.

The drawback of using thickener B was that, although it created a rather consistent gel-cream after the emulsification process, a good portion of that thickness was lost with the addition of the acids, and the partial neutralization of said acids did not recover the full consistency. To offset this effect, a higher amount of thickener had to be added to the formulation; carrying out the emulsification process with the dispersion equipment set to higher speeds was also helpful in maintaining an adequate thickness.

Furthermore, it was decided that the product would no longer be packaged within plastic flip-cap tubes, but rather in cylindrical pump containers, which offer better control when dispensing product of lesser thickness. Through these adjustments, a lightweight yet

pleasantly consistent gel-cream was produced; figure 11 displays the appearance of the product as it comes out of a pump-type packaging, as well as its texture upon spreading.



Figure 11: Appearance and texture of the renewed Margarita Anti Acne moisturizing gel-cream.

5.5. Formulation of the renewed moisturizing gel-cream

The reformulated MAA moisturizing gel-cream and its preparation method is presented below in table 12.

Table 12: Formulation of the renewed Margarita Anti Acne moisturizing gel-cream.

Phase	Raw materials (INCI)	Function	% (mass)
A	Dicaprylyl Ether	Emollient	2.00
	Undecane, Tridecane	Emollient	1.00
	Hydrogenated Polydecene	Thickener	2.00
	Tocopheryl Acetate	Antioxidant	0.50
B	Aqua	Solvent	to 100
	Glycerin	Humectant	2.00
	Betaine	Moisturizing agent	0.80
	Allantoin	Moisturizing agent	0.20
	Sodium Acrylates Copolymer, Lecithin	Thickener	2.00
C	Lactic Acid, 80%	Active ingredient, exfoliating acid	0.30
	Sodium Hydroxide	pH adjuster	0.07
	Aqua, Glycerin, Salix Alba (Willow) Bark Extract, Sodium Benzoate, Potassium Sorbate	Botanical active ingredient	1.00
	Aqua, Glycerin, Pyrus Malus (Apple) Fruit Extract, Sodium Benzoate, Potassium Sorbate	Botanical active ingredient	1.00
	Parfum	Fragrance	0.10
	Propanediol	Preservative	1.35
	Ethylhexylglycerin	Preservative	0.15

Product Technical Requirements

<i>Cost per 100 g</i>	0.18 €
<i>Appearance</i>	Off-white semi-opaque gel
<i>Scent</i>	Lady's Mantle (Herbal)
<i>pH</i>	4.5 – 6.0

Preparation:

1. Add all phase A ingredients together and mix.
2. Add all phase B ingredients, minus the thickener, and mix, using heat if needed.
3. Add the thickener to phase B while stirring.
4. Stir phases A and B together. Use a dispersing instrument at high speed to create a thick gel.
5. Add the acids and sodium hydroxide. This will cause the gel to lose some of its consistency. Use the dispersing instrument again to ensure no clumps form.
6. Add plant extracts, perfume, and preservatives under stirring.

6. REFORMULATION OF THE MULTIFUNCTIONAL GOMMAGE

6.1. Original formulation of the Margarita Anti Acne scrub-mask-wash

The fourth product in the original MAA line is the three-in-one scrub, mask and wash *gommage*, as described within table 13.

Table 13: Composition and description of product requirements for the Margarita Anti Acne scrub-mask-wash.

Raw materials, according to INCI name	Function	% (mass)
Aqua	Solvent	to 100
Glyceryl stearate SE	Emulsifier	4.00
Cetearyl Alcohol	Thickener	4.00
Tocopheryl Acetate	Antioxidant	0.50
Salicylic Acid	Active ingredient	1.00
Glycerin	Humectant	7.00
Xanthan Gum	Thickener	0.15
Sodium Polyacrylate	Thickener	0.45
Hydroxypropyl Starch Phosphate	Thickener	1.75
Panthenol	Skin conditioner	0.50
Sodium Stearoyl Glutamate	Emulsifier	0.25
Titanium Dioxide	Pigment	1.00
Zinc Oxide	Active ingredient	0.50
Phenoxyethanol, Ethylhexylglycerin	Preservative	0.70
Propylene Glycol, Aqua, Rubus Idaeus (Raspberry) Fruit Extract	Botanical active ingredient	0.10
Propylene Glycol, Aqua, Citrus Grandis (Grapefruit) Fruit Extract	Botanical active ingredient	0.10
Parfum	Scent	0.30
Alcohol Denat.	Solvent	0.30
Menthol	Cooling agent	0.02
Rubus Idaeus (Raspberry) Seed Powder	Abrasive	1.00
Bentonite	Absorbent, bulking agent	20.00

Product Technical Requirements

Appearance	Viscous cream with fine solid particle inclusions
Color	Light brown with brown particles
Thermal stability	Stable
Emulsion stability	Stable
Scent	Raspberry
pH	5.5 – 8.0
Maximum total microorganism colony-forming units (CFUs) in 1 g of product	1000
Amount of product, out of 1 g, not containing <i>Pseudomonas aeruginosa</i> , <i>Staphylococcus aureus</i> , <i>Candida albicans</i> , or <i>Escherichia coli</i>	1 g
Expiry date	18 months, from date of manufacture

Notes:

¹ At a mixture concentration of 0.7%: Phenoxyethanol - 0.64%.

This product relies on bentonite clay to create a mask capable of absorbing excess oil. Salicylic acid is featured as an anti-acne active ingredient, but the main exfoliation effect is delivered by finely milled raspberry seed powder. Menthol is also present, to offer a slight cooling sensation when the mask is applied to the skin. This product is intended for occasional (weekly or twice-weekly) use, by applying it to the facial skin and allowing it to sit until the clay begins to set, or by rinsing it off before the clay mask dries fully to enjoy it as a face wash. The physical exfoliation should be attained by gently massaging the product in circles on the skin, without applying excessive pressure.

The three-in-one scrub, mask and wash is commercialized in a 150 ml flip-cap plastic tube, for a total end consumer cost of 5.99 €.

6.2. Objectives of the reformulation of the multifunctional *gommage*

Clay masks and physical scrubs alike are both commonly sought by individuals with oily skin, and the multifunctionality of this Margarita product set it apart and helped it perform well in sales. Nevertheless, the use of clay masks has the potential to be drying to the skin and scrubbing acne-afflicted skin with abrasive particles can prove to increase inflammation and worsen the outcome of breakouts (61). Therefore, the goal of the reformulation of this product was to create a gentler alternative for physical exfoliation; for this reason, the *gommage* type of exfoliator was chosen, seeing as it does not rely on sharp-edged or hard particles, but rather on the balling-up effect of polymers dispersed in the product. *Gommages* are an innovative product in the Baltic drugstore cosmetic market, which adds to the appeal of this reformulation concept. It is also an entirely new formulation type within the BLOK product portfolio.

The desired characteristics of the *gommage* as described by the Marketing department proposal are as follows:

- *The product should be usable as a mask-scrub with cellulose particles;*
- *It should contain gommage-like particles that roll up against skin and collect impurities;*
- *It should be capable of deeply cleansing the pores and dissolve blackheads.*
- *It should soothe, moisturize and soften the skin.*
- *It should contribute to the prevention of new breakouts;*
- *It should provide gentle exfoliation.*

The product should be suitable for occasional use on acne-damaged skin. Beyond the cellulose powder — the elected polymer to produce the balling-up effect — the *gommage* also features chemical exfoliating properties due to the inclusion of both glycolic and lactic acid. Combined, these two methods of mild exfoliation are intended to aid in combatting the formation of acne breakouts by counteracting the overgrowth of keratinocytes and the clogging of pilosebaceous follicles.

6.3. Tester feedback results and subsequent changes to the *gommage*

The responses to the questionnaire about the *gommage* by the 25 respondents are summarized within table 14.

Table 14: Volunteer feedback from the questionnaire regarding the Margarita Anti Acne multifunctional *gommage*.

Questionnaire criteria		Testers who agree (%)	Number of answers
<i>Pleasantness of use</i>	Enjoyable consistency	84	25
	Adequate thickness	64	25
	Easy use	92	25
	Scent pleasantness	80	25
	Scent intensity	76	25
<i>Perceived effectiveness</i>	Softness of skin	79	19
	Blackhead improvement	37	19
	Cleansing sensation	96	24
	<i>Gommage</i> effect	80	25
	Use as mask	72	25
	Use as a spot treatment	12	25
<i>Presence of side effects</i>	Initial tingling/burning sensation	22	23
	Persistent tingling/burning sensation	0	23
	Initial redness	26	23
	Persistent redness	0	23
<i>Perceived added value</i>	Improvement over original	100	6
	Suitability for market	84	25

One of the concerns regarding this product was that its multifunctionality, combined with the novel type of exfoliation it introduced to the BLOK portfolio, may not be user-friendly. However, most testers (92%) rated the *gommage* as easy to use according to the instructions provided. Eighty percent were able to achieve the desired balling-up effect (although not all who did found it to be sufficient; 25% reported being dissatisfied with it, which led to changes in the incorporation process of the cellulose in an attempt to improve its performance). The product's ability to cleanse the skin was verified by 96% of testers,

and 72% successfully used it as a mask. Additionally, 12% used it as a spot treatment — a mode of usage not included in the product name, but one that was suggested after it was verified that, once the product was applied to an acne spot and left to dry, it formed a protective film-like layer while delivering the same active ingredients to the area.

In terms of other desired effects, 79% of users agreed that it left their skin softer, and 37% reported an improvement in blackheads. The latter effect in particular may be difficult to self-assess, especially during a short period of time, and further dermatological tests with more objective methodologies will be necessary to substantiate any claims made in this regard.

Pertaining to the sensorial properties of the product, 36% considered that its thickness was not satisfactory, mostly describing it as too thin. A very similar feedback to what was seen on previous products was received in terms of the fragrance, with an even split between those who considered it too strong and too weak, although the majority of testers was satisfied.

Redness and tingling sensations upon the initial applications were reported by 26% and 22% of volunteers, respectively, but once again these undesirable effects disappeared over time, and none reported experiencing them persistently.

All six of the volunteers who had previous experience with the original MAA line scrub with raspberry seed powder and clay preferred the *gommage* over the previous version. Eighty-four percent of testers considered this version ready for sale as is. Overall, the average rating of the *gommage* was of 5.4; the rating distribution is presented in figure 12.

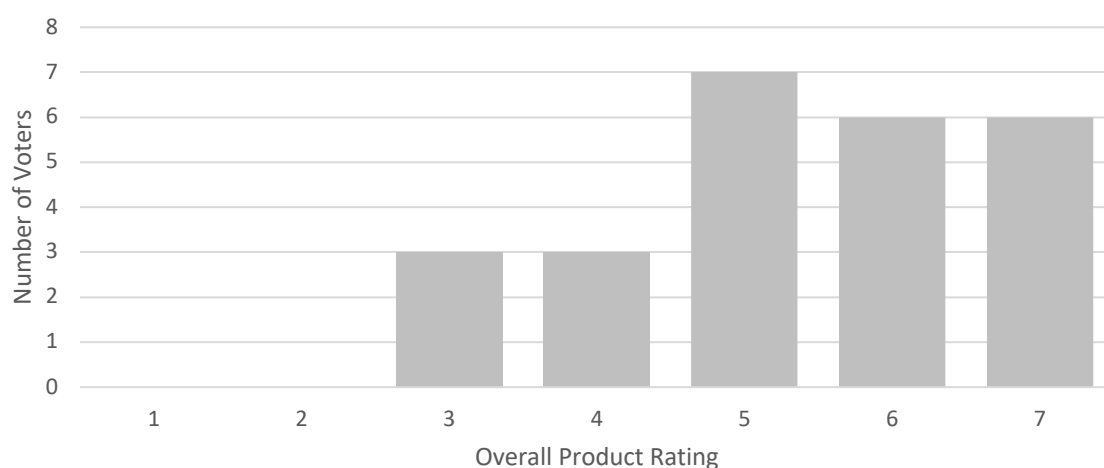


Figure 12: Rating distribution of the overall satisfaction with the prototype Margarita Anti Acne *gommage* formulation.

Most of the comments left by volunteers were positive: although “the balling-up effect was not achieved every time”, mentions one of the volunteers, “the softness of the skin after use is special” and they consider the product “a great tool”. Another compares it favorably against the original MAA product, describing it as “softer and more moisturizing” than the older version.

Some testers mentioned the scent was too weak, and others said the same of the exfoliating power: “the abrasiveness could be stronger to remove dead skin cells”. Another tester, however, shared that “after the first use [they] already liked the effectiveness of the scrub”, praising its “great texture”.

6.4. Challenges of the reformulation process of the *gommage*

The novelty of this formulation type within the BLOK portfolio, as well as the desired properties outlined in the previous section, led to this product being the most challenging to develop. Initially, a similar concept to the original (featuring bentonite clay for masking uses) was tested, but the prototypes showed that the presence of the clay impeded the balling-up effect of the cellulose, undermining the main appeal of the product. Similarly, the addition of an oil phase also compromised the effectiveness of the product in this regard, so the direction of the reformulation was changed towards a solely water-based product.

The viability of the balling-up effect proved to be the main constraint of this formulation. The cellulose powder selected was by far the most expensive material in the project (0.249 € per 100 g): although the amount of cellulose used in the *gommage* was kept as low as possible while still offering the desired effect, this still surpassed the product’s budget of 0.25 € per 100 g, and partly consumed the budget for other products in the line. Taking this into account, the overall cost of the remaining products had to be kept as low as possible to compensate this expense. However, even with the extra cost allowance allocated to the *gommage*, the lower amounts of cellulose meant that the balling-up effect of the final formulation was less dramatic than that of comparable products available in the market, and that it was also more liable to decrease due to the effects of additives, like thickeners.

Thickening the *gommage* did, in fact, pose issues, not merely due to the need to preserve the balling-up effect but also due to the presence of exfoliating acids, which limited the choice of thickeners. Prototypes were created and assessed combining differing percentages of cellulose gum, xanthan gum and thickener B, but ultimately a compromise had to be made to maintain the *gommage* effect of the cellulose powder. Therefore, the final version of the formulation had a slightly runny gel-like consistency with extremely fine

particles of cellulose dispersed within (figure 13); at the end of the reformulation project, different alternatives for packaging to accommodate this texture were considered, including soft plastic tubes with narrow openings and single-use sachets. Ultimately, the decision was relayed to the Marketing Department, for later stages of development.



Figure 13: *Gommage* (balling-up) effect of the reformulated scrub-mask-wash, and its appearance and texture.

The final hurdle in the development of this formulation occurred during the initial phases of volunteer testing, where a few users reported feeling some redness, tingling and irritation after application. Upon conferring the pH levels of the prototype formulation used in the trial, it was apparent that it had decreased to levels around 3, hinting at some instability in the formulation caused by the higher amount of acids. Initially, the product had been conceptualized as a dual-effect, rinse-off exfoliating mask, relying on a higher concentration of AHAs than the other products in the line, in addition to the *gommage* effect. This vision was abandoned for the sake of maintaining a mild, non-irritating profile and preventing such a steep decrease in pH, and the concentration of AHAs was halved in the final formulation, improving its overall stability.

6.5. Formulation of the renewed multifunctional *gommage*

Table 15 describes the composition and preparation of the reformulated version of the MAA facial scrub-mask-wash. The overall cost of this product, in terms of raw materials, was the highest within the line (0.36 € /100 g) and surpassed the budget allocated per product. However, the lower cost of the toner (0.08 € /100 g), the cleanser (0.13 € /100 g) and the gel-cream (0.18 € /100 g) offset this spending so that, when taken together, the spending on raw materials for the MAA line was 25% under the allocated budget.

Table 15: Formulation of the renewed Margarita Anti Acne *gommage*.

Raw materials (INCI)	Function	% (mass)
Aqua	Solvent	to 100
Glycerin	Humectant	2.00
Cellulose Gum	Thickener	0.75
Xanthan Gum	Thickener	0.20
Sodium Acrylates Copolymer, Lecithin	Thickener	1.20
Glycolic Acid, 70%	Active ingredient, exfoliating acid	1.50
Lactic Acid, 80%	Active ingredient, exfoliating acid	1.50
Sodium Hydroxide	pH adjuster	1.00
Aqua, Glycerin, Salix Alba (Willow) Bark Extract, Sodium Benzoate, Potassium Sorbate	Botanical active ingredient	0.50
Aqua, Glycerin, Pyrus Malus (Apple) Fruit Extract, Sodium Benzoate, Potassium Sorbate	Botanical active ingredient	0.50
Parfum	Fragrance	0.10
Propanediol	Preservative	1.35
Ethylhexylglycerin	Preservative	0.15
Cellulose	<i>Gommage</i> effect	10.00

Product Technical Requirements

Cost per 100 g	0.36 €
Appearance	Opaque white gel with very fine particles dispersed
Scent	Lady's Mantle (Herbal)
pH	3.8 – 5.5

Preparation:

1. Disperse the cellulose gum and xanthan gum within the glycerin.
2. Add water slowly and gradually while stirring.
3. Gradually add the sodium acrylates copolymer and lecithin-based thickener; use the dispersing instrument to homogenize the mixture.
4. Add the acids, the sodium hydroxide, the plant extracts, the fragrance, and the preservatives.
5. Add the cellulose powder gradually, while stirring at very high speeds. Leave the stirring on for a few minutes after the cellulose powder has been fully incorporated, to ensure the destruction of any clumps.

Should the company consider it worthwhile, the 25% margin of savings could be reinvested into this product, given that it is the most innovative one in the lineup and

therefore has the potential to be very appealing, as demonstrated by the reviews in the preliminary volunteer testing. Increasing the quantity of cellulose in 3 to 5%, though relatively costly when compared to the other ingredients, could have a double benefit within this formulation: an improved balling-up effect, and thickening of the product that could allow for the reduction of the amount of other viscosity modifiers — which also aids the performance of the *gommage*, since it has been verified that higher amounts of thickeners hinder the desired effect, as discussed above.

7. DOCUMENTATION AND SUBSEQUENT STEPS FOR COMMERCIALIZATION

7.1. Product Information File

The Product Information File (PIF) is a piece of documentation required for the placement of a product in the market according to the EU Regulation 1223/2009. This document serves as a compilation of all the necessary information about a cosmetic product, which should be kept by the responsible person at the address indicated on the product's label, readily available to the competent authority of the EU member state where the responsible person is based. The PIF must be written in a language that is comprehensible by said competent authority, and it must be maintained for ten years after the last batch of the product is placed on the market (120).

The PIF must contain a description of the cosmetic product, the Cosmetic Product Safety Report (CPSR), the method of manufacturing and proof of compliance with good manufacturing practices, proof of the effect claimed (when justified), product labelling, and data on any animal testing performed by the manufacturer or its suppliers relating to the finished product or its ingredients. These contents are standardized and not subject to change, regardless of the type of product in question. This information provides the basis for the notification to the EU Cosmetic Product Notification Portal (CPNP), which is mandatory before the placement of any cosmetic on the European market.

Naturally, as the product development was not finished at the end of this project, a large amount of the information necessary for the construction of the PIF was not yet available. Therefore, only the initial collection of data for the CPSR was completed at the conclusion of the project.

7.2. Safety Report

The safety assessment of a cosmetic product is another requirement for its placement in the market, to prove its compliance with Article 3 of the EU Regulation 1223/2009 which states that a “cosmetic product made available on the market shall be safe for human health when used under normal or reasonably foreseeable conditions of use”. The findings of this safety assessment should be compiled into the CPSR, according to Annex I of the same Regulation. The safety assessment must take into account the effects of the finished product's anticipated use, as well as those of the systemic exposure to each ingredient it contains.

The structure of the CPSR is divided into two sections, parts A and B. Part A corresponds to the cosmetic product safety information, and includes the quantitative and qualitative composition of the cosmetic product; its physical/chemical characteristics and stability; its microbiological quality; impurities, traces, information about the packaging material; normal and reasonably foreseeable use; exposure to the cosmetic product; exposure to the substances; toxicological profile of the substances; undesirable effects and serious undesirable effects; and other information on the cosmetic product. Part B comprises the cosmetic product safety assessment, and contains the assessment conclusion, labelled warnings and instructions of use, the reasoning behind the conclusion of the safety assessment, and the assessor's credentials and approval. The assessor must possess university-level practical and theoretical qualifications in pharmacy, toxicology, medicine, or a course recognized as equivalent (120).

The segments of information that were gathered within the duration of this process all pertained to part A of the CPSR and are further detailed below.

7.2.1. Qualitative composition of the cosmetic product

Regarding the portion of the CPSR that is concerned with the composition of the cosmetic product, it is necessary to compile and describe its list of ingredients according to their INCI designation. All substances and mixtures intentionally used in the cosmetic product during the manufacturing process, save for impurities in the raw materials used or for technical materials used during the process but absent from the final product, must be included as ingredients. The INCI list must be ordered in descending order of the amount of the ingredient present, by weight, excepting concentrations lower than 1%, which may be listed in any order after the ingredients in concentrations greater than 1%. Fragrances and aromatic compounds should be listed under the generic designations of 'parfum' or 'aroma'; furthermore, Annex III of the EU Regulation 1223/2009 lists substances that must be indicated in addition to the fragrances and aromas, should they be present (120).

Given these directives for the creation of the INCI lists of each product, those of the reformulated MAA line are given below in table 16. In addition to this qualitative description of the products, it will be necessary to create a quantitative one as well, which takes into account the overall percentages of each substance present within the formulation, rather than the broad percentages of raw materials, which are sometimes diluted and sometimes a mixture of substances, indicated in the formulation tables present in the previous chapters. These exact percentages will become the basis for cumulative systemic exposure calculations, another important aspect of the CPSR.

Table 16: Ingredient lists of the products within the reformulated Margarita Anti Acne line, according to their INCI designations and to the EU Regulation 1223/2009.

Facial Gel Cleanser	Moisturizing Gel-cream
Aqua, Glycerin, Coco-Glucoside, Cocamidopropyl Betaine, Sodium Cocoyl Glutamate, PEG/PPG-120/10-trimethylolpropane Trioleate, Laureth-2, Propanediol, Glyceryl Oleate, Salix Alba (Willow) Bark Extract, Pyrus Malus (Apple) Fruit Extract, Sodium Benzoate, Potassium Sorbate, Lactic Acid, Allantoin, Ethylhexylglycerin, Parfum (Citronellol, Hexyl Cinnamal, Limonene, Linalool) , Sodium Hydroxide	Aqua, Dicaprylyl Ether, Hydrogenated Polydecene, Sodium Acrylates Copolymer, Lecithin, Glycerin, Propanediol, Undecane, Tridecane, Pyrus Malus (Apple) Fruit Extract, Salix Alba (Willow) Bark Extract, Sodium Benzoate, Potassium Sorbate, Lactic Acid, Allantoin, Tocopheryl Acetate, Betaine, Ethylhexylglycerin, Parfum (Hexyl Cinnamal, Citronellol, Limonene, Linalool), Sodium Hydroxide
Exfoliating Toner	3-in-1 Scrub-Mask-Wash
Aqua, Lactic Acid, Sodium Hydroxide, Glycerin, Glycolic Acid, Propanediol, Pyrus Malus (Apple) Fruit Extract, Salix Alba (Willow) Bark Extract, Sodium Benzoate, Potassium Sorbate, Allantoin, Betaine, Potassium Alum, PEG-40 Hydrogenated Castor Oil, Ethylhexylglycerin, Parfum (Hexyl Cinnamal, Citronellol, Limonene, Linalool)	Aqua, Cellulose, Glycerin, Propanediol, Sodium Acrylates Copolymer, Lecithin, Lactic Acid, Glycolic Acid, Pyrus Malus (Apple) Fruit Extract, Salix Alba (Willow) Bark Extract, Sodium Benzoate, Potassium Sorbate, Cellulose gum, Xanthan Gum, Ethylhexylglycerin, Parfum (Hexyl Cinnamal), Sodium Hydroxide

7.2.2. *Physical/chemical characterization and stability of the cosmetic product*

A cosmetic product must be tested to ensure its properties are not altered for the duration of its shelf life, and that it will not pose a risk to the health of the consumer. As such, the stability testing phase is a key part of product development within the cosmetic industry: should the results of such testing reveal any issues, the entire formulation may need to be reworked or scrapped altogether. For this reason, it is common practice to carry out preliminary stability checks during the initial phases of product development, by maintaining prototype versions of each formulation under accelerated stability testing conditions, as well as at room temperature and under refrigeration, so as to assess how the product behaves and whether its properties are compromised.

This was the type of stability testing carried out within this reformulation project, although longer and more thorough tests will be conducted, according to European regulations. However, the limited time frame of the project meant that, by the time of its conclusion, these thorough assessments were still at its earliest stages. Nevertheless, the data from the preliminary stability testing already allows for some conclusions to be drawn. The refrigerated samples, kept at 45 °C for the duration of the testing, were mainly controlled for the formation of crystals, particularly within liquid moieties (namely, the toner). No issues or alterations in the product's properties were observed.

Table 17 summarizes the accelerated stability data obtained by the end of the project. Ordinarily, accelerated stability testing within BIOK is carried out at 45 °C for at least 35 days, which correspond to a shelf life at room temperature of 12 months, and then continued for a total of 70 days (corresponding to a 24-month shelf life), then 100 days (corresponding to a 36-month shelf life) (132); the data thus obtained is invaluable not only to establish the overall viability of the formulation, but also to substantiate necessary labelling information, such as the expiration date or Period After Opening (PAO). In this case, given the duration of the project, data were collected after 35 days, with the remaining stability checks being carried out in the future to complete the necessary information.

Table 17: Accelerated stability preliminary results for the Margarita Anti Acne line reformulations.

Product	Specification	Date of testing	
		2020/01/24 ¹	2020/02/28 ²
Gel Cleanser			
Consistency	Gel	Corresponds	Corresponds
Color	Clear	Corresponds	Corresponds
Aroma	Herbal	Corresponds	Corresponds
pH	4.5 – 5.5	5.2	5.1
Exfoliating Toner			
Consistency	Liquid	Corresponds	Corresponds
Color	Clear	Corresponds	Corresponds
Aroma	Herbal	Corresponds	Corresponds
pH	3.8 – 5.5	4.9	4.5
Gel-Cream			
Consistency	Gel-like, creamy	Corresponds	Corresponds
Color	Off-white	Corresponds	Corresponds
Aroma	Herbal	Corresponds	Corresponds
pH	4.5 – 6.0	5.6	5.0
Colloidal stability		Stable	Stable
Thermostability		Stable	Stable
Scrub-Mask-Wash			
Consistency	Gel with fine particles	Corresponds	Corresponds
Color	White	Corresponds	Corresponds
Aroma	Herbal	Corresponds	Corresponds
pH	3.8 – 5.5	4.2	4.2

¹ Samples freshly prepared for stability testing, before being placed in the thermostat.

² Samples kept in the thermostat at 45 °C for the duration of the stability testing.

As table 17 indicates, no significant alterations occurred in the sensorial properties (consistency, color, aroma) of any of the samples. The pH of each sample was also controlled; the in-house standards for acceptable pH variations dictate that the measured values should be within the specified range for each product, and that they should not have a variation greater than 1 over time. According to this guideline, all samples are considered stable, although all but the *gommage* show a decrease in pH. The greatest decrease

occurred within the gel-cream (a variation of -0.6), which may pose an issue should the product continue to acidify over time; data from subsequent stability checks will be important to establish whether the formulation should be altered to ensure a lesser variation.

Additionally, and given the biphasic nature of the gel-cream, the stability of the emulsion was also tracked; its thermostability was evaluated through whether any separation of oil and water phases occurred after permanence in the thermostat, and its colloidal stability was evaluated via centrifugation. In both cases, the product was stable, showing that the cold-process emulsification method is sufficient to maintain the integrity of the gel-cream.

7.3. Microbiological quality

The microbiological testing of the reformulated MAA line was carried out by the Quality Control Laboratory within BIOK. According to the Notes on Guidance for Testing of Cosmetic Ingredients and Their Safety Evaluation published by the SCCS, all products of the MAA line are part of Category 2 in terms of their microbiological requirements, given that they are not specifically intended for children under 3 years, nor for application on the eye area or mucous membranes. This renders them of a lower microbiological risk; therefore, the total viable count of microorganisms in the samples must not exceed 1×10^3 colony-forming units (CFU) per milliliter or per gram, and the pathogenic bacteria *Escherichia coli*, *Pseudomonas aeruginosa* and *Staphylococcus aureus* as well as the yeast *Candida albicans* must not be present in 1 g or 1 ml of the product (133). In all product samples of the MAA line, these microbiological requirements were fulfilled.

Challenge tests of the products were outsourced, as the suppliers of the preservative ingredients offered them as a service. Samples for these tests were prepared for this end according to the formulas and methodologies outlined in previous chapters. Furthermore, given that issues had arisen during the challenge testing of different BIOK product lines in development that contained the same preservative system, alternative formulations of the MAA line (where the only ingredients and quantities changed were those of the preservatives) were prepared and sent for challenge testing. These formulations featured, instead of ethylhexylglycerin and propanediol, either preservative A (Phenoxyethanol, Ethylhexylglycerin) at 0.8% or preservative B (Aqua, Sodium Benzoate, Potassium Sorbate) at 0.8%. Additional samples of all the variants for each product were also produced for stability testing, although no data was yet available by the end of the project. These preservative variants were created to avoid delays in production, as stability tests are carried out, should the original formulation fail the microbiological challenge tests.

Both alternatives using preservatives A and B, however, posed the same issue; the odor of the preservatives was very much detectable despite the presence of added fragrance, which may require an adjustment in the type or quantity of the perfume so as to better mask it.

7.4. Future steps for the Margarita Anti-Acne line

Due to the time constraints inherent to the length of this project when compared with the total duration of cosmetic product development, not all information necessary to complete the documentation of the MAA line was yet obtained. The remaining sections of the CPSR and the PIF shall be completed over time, as test results are received, the packaging and labelling process is advanced, and the pilot batches are prepared. The formulations of each product are still likely to undergo adjustments according to the results of challenge, dermatological and in-use tests; the formulations presented in previous chapters should not, therefore, be taken as final, but as an approximation of the end product and a representation of the bulk of the cosmetic formulation work that took place within the project. Once the final products are settled upon and all the required documentation is produced, these will serve as the basis for the CPNP notification before the products are placed on the market in the EU Baltic states.

However, the renewal of the MAA line will not necessarily end once this milestone is accomplished; as previously discussed, the cosmetic industry thrives from innovation at an ever-accelerating pace, as the life cycle of products shortens, and consumers demand novelty and increased effectiveness. As such, it is only natural that further reformulations and potential expansions to the line will occur. One such expansion that would add value to the MAA line would be the creation of a sunscreen suitable for acne-prone skin, as the use of sun protection is recommended for all individuals and sun exposure can aggravate the inflammatory processes of acne (60,67). Other additions might include serums, which have seen a great surge in popularity in recent years as a means of delivering specific active ingredients at higher dosages, creating the possibility of tailoring a skin care routine to the skin's specific needs at each moment. These serums might include ingredients which have been associated with acne improvement, such as those discussed in section 1.2.3.

The present reformulation of the MAA line could be further improved with the allocation of an even slightly increased budget. While it is true that Margarita as a brand is established as a very low-cost drugstore option, the MAA line sought to present a more expert image, with ambitious products in its lineup and higher concentrations of active ingredients. However, by maintaining the price point of the original line, it was necessary to reach a compromise in terms of the structural ingredients responsible for the texture, skin

feel, and overall sensorial appeal of the products; these ingredients are also those that may impart the desired mildness to the products, so as to avoid further irritating acne-prone skin, even in the presence of stronger active ingredients. Therefore, the “expert skin care” branding, targeting older teens, young adults and even lifelong sufferers of adult acne (whereas the original MAA line catered mostly to a younger consumer base), could be better transmitted through more cosmetically elegant formulations, if at a marginally higher price point.

8. CONCLUSIONS

The development of skin care products is a complex and time-consuming process, where the actual formulation work is only one step in a pipeline that can take upwards of a year to complete. Formulating cosmetics with acne-prone skin in mind is particularly challenging, given the diversity in the severity and presentation of this disease, which has systemic causes and risk factors that are not yet completely understood. Skin care may be unable to offer a cure, especially in chronic cases of moderate to severe presentation, but it may be an invaluable adjuvant in tandem with medical treatment, increasing compliance with medication by mitigating its side effects and helping maintain the results of therapy over time. It is important to strike a balance between effectiveness, with active ingredients backed by scientific evidence of their benefits for acne-prone skin, and mildness, so as to avoid increasing cutaneous irritation, which may lead to a worsening of the condition and to lasting scars and blemishes.

This project sought to combine the trend appeal of natural, plant-derived ingredients (apple and willow bark) with extensively researched AHAs (lactic and glycolic acids), which have been shown to be helpful in addressing acne. The formulation process was, therefore, based on current dermatological guidelines for the management of acne, but also on the pillars of the Margarita brand: Baltic nature, Baltic traditions, and the needs of Baltic peoples' skin. Some compromises were necessary, for the sake of the marketability of the product and for maintaining a low-cost price point, but the initial steps of product development, from concept to ingredient selection, formulation, testing by volunteers, and early stability testing, were successfully carried out.

Three products, a cleanser, a toner, and a moisturizer, were reformulated, and one entirely new one (the multifunctional *gommage*) was introduced to the BLOK portfolio. The range of MAA products now offers a more professional-feeling, adult image with stronger actives and innovative formulations that cover a complete skin care routine, with the exception of sun protection. The development of a sunscreen could be a suitable next step for its expansion. Overall, the product development process within BLOK could benefit from the implementation of more organized quality control at the initial steps of formulation and in-house volunteer testing.

The development of the MAA is not yet complete; however, it has been largely advanced during the duration of this project, and the line will reach the market in late 2020 or early 2021, to supply affordable solutions for those who seek a way to mitigate the impact of their acne.

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ANNEX I

PROTOTYPE FEEDBACK QUESTIONNAIRES

Note: The number of volunteers that selected each option is indicated within brackets or inside the scale boxes.

A. Margarita Anti Acne Moisturizing Facial Gel-cream (Total of respondents: 26)

This is an update to the existing Margarita Anti-Acne line gel-cream product, with an increased concentration of exfoliating alpha-hydroxy acids, hydrating apple extract and astringent willow bark extract, created with oily and acne-prone skin in mind. The texture, natural extracts, scent and acid concentration have been changed from the original product.

1. How would you describe your skin usually/before using the Margarita Anti Acne line?

Select all that apply.

- | | |
|---|--|
| ☐ Oily (7) | ☐ Sensitive (5) |
| ☐ Dry (4) | ☐ Acne/blemish-prone (13) |
| ☐ Combination (15) | ☐ Other: (0) |
| ☐ Dehydrated (7) | _____ |

2. Have you used products containing exfoliating acids (lactic acid, glycolic acid, etc.) previously?

- ☐ Yes, frequently (6)
- ☐ Yes, occasionally (14)
- ☐ No, never (6)

3. Did you notice any overall changes to your skin after using the Margarita Anti Acne line?

Select all that apply.

- | | |
|--|---|
| ☐ Skin feels tighter (3) | ☐ Irritation (1) |
| ☐ Skin feels greasier (0) | ☐ Redness (2) |
| ☐ Skin feels less greasy (9) | ☐ Itchiness (1) |
| ☐ Skin feels more hydrated (12) | ☐ Less blackheads/whiteheads (6) |
| ☐ Skin feels softer (15) | ☐ More blackheads/whiteheads (0) |
| ☐ Skin feels rougher (0) | ☐ Other: (0) |
| ☐ Pores appear tighter (11) | _____ |

4. Did you enjoy the consistency of the Margarita Anti-Acne gel-cream moisturizer?

	1	2	3	4	5	6	7	
Did not enjoy at all	0	1	0	2	5	12	6	Really enjoyed it

5. How would you describe the consistency?

- ☐ Too thick (1)
- ☐ Adequate (17)
- ☐ Too thin (8)

6. Did the product leave your skin moisturized?

	1	2	3	4	5	6	7	
Not at all	0	0	1	5	5	8	7	Very moisturized

7. Was the cream absorbed quickly into the skin?

	1	2	3	4	5	6	7	
Very slowly	0	0	0	4	1	8	13	Very quickly

8. Did you experience a refreshing sensation during application to the skin?

- ☐ Yes (11)
- ☐ No (5)
- ☐ Did not notice (10)

9. Did you experience a mattifying effect after the product dried down?

- ☐ Yes (13)
- ☐ No (5)
- ☐ Did not notice (8)

10. Did the product leave any sticky residue on the skin?

- ☐ Yes (3)
- ☐ No (21)
- ☐ Did not notice (2)

11. Did you notice any tingling or burning sensation after application?

- ☐ Yes, on the first application(s) but it decreased with use (3)
- ☐ Yes, and it made me discontinue usage of the product (0)
- ☐ No, I did not feel it (23)
- ☐ Did not notice (0)

12. Did you notice any redness after application?

- ☐ Yes, on the first application(s) but it decreased with use (4)
- ☐ Yes, and it made me discontinue usage of the product (0)
- ☐ No, I did not feel it (21)
- ☐ Did not notice (1)

13. Did you enjoy the scent of the product?

	1	2	3	4	5	6	7	
Really disliked it	2	1	3	3	4	5	8	Really liked it

14. Was the scent intensity appropriate?

- ☐ Yes (20)
- ☐ No, it was too intense (3)
- ☐ No, it was too weak (3)

15. Did you notice any shine/gloss on the skin after using this product?

- ☐ Yes, immediately after application (5)
- ☐ Yes, after a while (8)
- ☐ No, I didn't notice any shine (13)

16. Have you ever used the Margarita Anti-Acne gel-cream with raspberry extract from the original line? If so, how does this version compare?

- ☐ Yes, I like this new version more (6)
- ☐ Yes, I like the old version more (3)
- ☐ No/I don't remember (17)

17. Is this version of the product suitable for sale?

- ☐ Yes (24)
- ☐ No (2)

18. Additional comments after using Margarita Anti Acne gel-cream with apple and willow extracts

19. Please give the Margarita Anti Acne gel-cream with apple and willow extracts an overall rating:

	1	2	3	4	5	6	7	
Very bad	0	0	0	6	6	7	7	Very good

20. Your name: _____

B. Margarita Anti Acne Facial Cleanser

This is an update to the existing Margarita Anti-Acne line facial cleanser product, with an increased concentration of exfoliating alpha-hydroxy acids, hydrating apple extract and astringent willow bark extract, created with oily and acne-prone skin in mind. The natural extracts, scent and acid concentration have been changed from the original product.

1. Did you enjoy the consistency of the cleanser?

	1	2	3	4	5	6	7	
Did not enjoy at all								Really enjoyed it

2. How would you describe the consistency?

- ☐ Too thick
- ☐ Adequate
- ☐ Too thin

3. Did the product cleanse your skin effectively?

- ☐ Yes
- ☐ No

4. Did you experience dryness or tightness of the skin after using the cleanser?

- ☐ Yes
- ☐ No
- ☐ Did not notice

5. Did you notice any tingling or burning sensation after application?

- ☐ Yes, on the first application(s) but it decreased with use
- ☐ Yes, and it made me discontinue usage of the product
- ☐ No, I did not feel it
- ☐ Did not notice

6. Did you notice any redness after application?

- ☐ Yes, on the first application(s) but it decreased with use
- ☐ Yes, and it made me discontinue usage of the product
- ☐ No, I did not feel it
- ☐ Did not notice

7. Did you enjoy the scent of the product?

	1	2	3	4	5	6	7	
Really disliked it	☐	☐	☐	☐	☐	☐	☐	Really liked it

8. Was the scent intensity appropriate?

- ☐ Yes
- ☐ No, it was too intense
- ☐ No, it was too weak

9. Have you ever used the Margarita Anti-Acne cleanser with raspberry extract from the original line? If so, how does this version compare?

- ☐ Yes, I like this new version more
- ☐ Yes, I like the old version more
- ☐ No/I don't remember

17. Is this version of the product suitable for sale?

- ☐ Yes
- ☐ No

18. Additional comments after using Margarita Anti Acne facial cleanser with apple and willow extracts

19. Please give the Margarita Anti Acne cleanser with apple and willow extracts an overall rating:

	1	2	3	4	5	6	7	
Very bad	☐	☐	☐	☐	☐	☐	☐	Very good

20. Your name: _____

C. Margarita Anti Acne Exfoliating Facial Toner

This is an update to the existing Margarita Anti-Acne line toner product, with an increased concentration of exfoliating alpha-hydroxy acids, hydrating apple extract and astringent willow bark extract, created with oily and acne-prone skin in mind. The natural extracts, scent and acid concentration have been changed from the original product.

1. Was the toner absorbed quickly into the skin?

- ☐ Yes
- ☐ No

2. Did the toner leave any stickiness on the skin?

- ☐ Yes
- ☐ No
- ☐ Did not notice

3. Did you notice any difference in the appearance of your pores after using the toner?

- ☐ Yes, they appear tighter after application
- ☐ Did not notice any difference

4. Did you notice any tingling or burning sensation after application?

- ☐ Yes, on the first application(s) but it decreased with use
- ☐ Yes, and it made me discontinue usage of the product
- ☐ No, I did not feel it
- ☐ Did not notice

5. Did you notice any redness after application?

- ☐ Yes, on the first application(s) but it decreased with use
- ☐ Yes, and it made me discontinue usage of the product

- ☐ No, I did not feel it
- ☐ Did not notice

6. Did you enjoy the scent of the product?

	1	2	3	4	5	6	7	
<i>Really disliked it</i>								<i>Really liked it</i>

7. Was the scent intensity appropriate?

- ☐ Yes
- ☐ No, it was too intense
- ☐ No, it was too weak

8. The glycolic acid and lactic acid are present in higher concentrations and therefore have a distinct odor that is not completely masked by the scent of the product. Was this odor tolerable?

- ☐ Yes
- ☐ No
- ☐ Did not notice

9. Have you ever used the Margarita Anti-Acne toner with raspberry extract from the original line? If so, how does this version compare?

- ☐ Yes, I like this new version more
- ☐ Yes, I like the old version more
- ☐ No/I don't remember

10. Is this version of the product suitable for sale?

- ☐ Yes
- ☐ No

18. Additional comments after using Margarita Anti Acne toner with apple and willow extracts

19. Please give the Margarita Anti Acne toner with apple and willow extracts an overall rating:

	1	2	3	4	5	6	7	
Very bad	☐	☐	☐	☐	☐	☐	☐	Very good

20. Your name: _____

D. Margarita Anti Acne Cleansing Mask-Scrub

This is a new addition to the existing Margarita Anti-Acne line, with an innovative gommage-effect gentle scrubbing action and a multipurpose use (as a mask, scrub and spot treatment), containing exfoliating alpha-hydroxy acids, hydrating apple extract and astringent willow bark extract, created with oily and acne-prone skin in mind.

1. Did you enjoy the consistency of the mask-scrub?

	1	2	3	4	5	6	7	
Did not enjoy at all	☐	☐	☐	☐	☐	☐	☐	Really enjoyed it

2. How would you describe the consistency?

- ☐ Too thick
- ☐ Adequate
- ☐ Too thin

3. Did your skin feel clean after rinsing off the product?

- ☐ Yes
- ☐ No
- ☐ Did not notice

4. Was the product easy to use based on the instructions provided?

- ☐ Yes
- ☐ No

5. Did you enjoy the balling effect of the product?

- ☐ Yes
- ☐ No
- ☐ Did not achieve this effect

6. Evaluate the feel of the scrub on the skin.

	1	2	3	4	5	6	7	
Very harsh	☐	☐	☐	☐	☐	☐	☐	Very gentle

7. Did the scrub leave your skin feeling softer and/or smoother?

- ☐ Yes
- ☐ No
- ☐ Did not notice

8. Did you use the product as a mask, and if so for how long did you leave it on?

- ☐ No, I always rinsed it off immediately after application
- ☐ Yes, for 1-5 min
- ☐ Yes, for 5-10 min
- ☐ Yes, for longer than 10 min

9. Did you use the product as a spot treatment for active acne?

- ☐ Yes, I enjoyed it
- ☐ Yes, it was neutral
- ☐ Yes, I did not enjoy it
- ☐ Did not try it as a spot treatment

10. Did you notice any improvement in any existing blackheads after using the scrub?

- ☐ Yes, I noticed improvements
- ☐ No, there was no improvement
- ☐ I don't have blackheads
- ☐ Did not notice

4. Did you notice any tingling or burning sensation after application?

- ☐ Yes, on the first application(s) but it decreased with use
- ☐ Yes, and it made me discontinue usage of the product
- ☐ No, I did not feel it
- ☐ Did not notice

5. Did you notice any redness after application?

- ☐ Yes, on the first application(s) but it decreased with use
- ☐ Yes, and it made me discontinue usage of the product

- ☐ No, I did not feel it
- ☐ Did not notice

6. Did you enjoy the scent of the product?

	1	2	3	4	5	6	7	
<i>Really disliked it</i>								<i>Really liked it</i>

7. Was the scent intensity appropriate?

- ☐ Yes
- ☐ No, it was too intense
- ☐ No, it was too weak

9. Have you ever used the Margarita Anti-Acne 3-in-1 mask/scrub/cleanser with raspberry extract from the original line? If so, how does this version compare?

- ☐ Yes, I like this new version more
- ☐ Yes, I like the old version more
- ☐ No/I don't remember

10. Is this version of the product suitable for sale?

- ☐ Yes
- ☐ No

18. Additional comments after using Margarita Anti Acne mask-scrub with apple and willow extracts

19. Please give the Margarita Anti Acne mask-scrub with apple and willow extracts an overall rating:

	1	2	3	4	5	6	7	
<i>Very bad</i>								<i>Very good</i>

20. Your name: _____