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Odor Masking, Stability and Sensoriality: Researching Background agents in Complex Systems for Infinite Solutions

Giulio Gennari, and Antonio Mazzucco*

Department for Life Quality Studies, University of Bologna, Italy

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***Corresponding author:**
Antonio Mazzucco
Department for Life Quality Studies
University of Bologna
Italy
E-mail: antonio.mazzucco@unibo.it

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Abstract

Consumers are increasingly aware and threatened by skin-related concerns. They face an increasingly hectic lifestyle and harsh environmental conditions, so they pay more attention to their state of health and increase their level of awareness. The available literature is full of examples using cosmeceuticals and pharmaceuticals that demonstrate multiple beneficial activities. However, this trend creates obstacles in the formulation due to the need to manage the organoleptic properties of the finished products, for example the emission of "unpleasant" odours. The emission of unpleasant odours inevitably tends to directly or indirectly compromise the entire formulation and its "sensory pleasantness". In fact, it is of fundamental importance to take into account that cosmetics, unlike drugs, are not intended to cure, but are characterized by a complex interaction between psyche, skin and product. The analysis of the social context and the context of use of the product is growing strongly to ensure the growth of this sector. Cosmetic products are designed to offer pleasant sensory experiences and meet different human needs. In cosmetics the sensory experience is given through the cosmetic "vehicle" transmitting a unique sensation to the skin thanks to its ingredients.

Keywords: Cosmetics; Cosmetic Science; Odour Masking; Cosmeceuticals; Stability; Sensory Analysis.

Introduction

In this context, the author of this study carried out research focused on an active chemical compound (in the form of powder) rich in naturally occurring substances, which is characterized by unfavourable sensory properties. The active investigated is well known in the literature for its biological effects including anti-aging. In fact, its biological matrix is rich in animal-derived hydrolyzed collagen type II (HC) and hyaluronic acid (HA), obtained through a patented extraction process, according to available data. This food-nutraceutical grade product is a prime example of the current concept of the beauty and personal care market "inside and out" and is designed for topical and dietary use (as a supplement). On the one hand, cosmeceuticals allow a manufacturer to create a compelling marketing story to play around. On the other hand, active ingredients rarely condition the whole skin feel in order to wow the final consumer. Nevertheless, the formulator has to cope with technological concerns regarding relevant substance-related characteristics, which generally drive a negative impact on the final result. In a broader picture, this cross-sectional trend or, say, "cross-contamination" of categories (e.g. nutraceuticals and cosmetic products) is gaining the momentum.

As claimed by the manufacturer, the ingredient is designed to provide a high concentration of bio-actives and, because of the nature of this specific ingredient, and above-the-average bioavailability. Hence, these technological properties can be leveraged to set a compelling point of difference as opposed to other commercialized products with marine-derived collagen, for instance. Due to its particular source, however, the extraction process of this ingredient tends to lead to a kind of raw material featuring unpleasant olfactory characteristics and, as a consequence, diminishing the "compliance" of the formulation overall. In other words, the detection of this characteristic odour from the customer side tends to prevent the usage of this specific raw material into many formulas aimed to please the final consumer. It is not uncommon to notice a lack of valid, accessible alternatives in terms of *odour-masking* solutions in the market of raw materials. With the term "odour-masking", the author refers to a specific and intricate chapter of the world of sensory analysis. In fact, there are a series of conditions that have to occur behind to plausibly assume the manifestation of this phenomenon.

Methodology and Rationale

Since biology and cosmetic science is said to be like a "black box" for the average consumer, the dilemma between theory, subjective needs and practice and objective effects raise an issue thereof is difficult to solve due to confused answers. In fact, while instrumental methodologies have become highly sensitive and accurate, plenty of questions still tend to be raised wondering the relevancy of such small differences between products for consumers who are not always able to detect them. Symbolically, the complexity of the product development process for cosmetics can be pictured as the "magic formulation triangle". Three cornerstones such as stability, activity, and feasibility should coexist to have a well-designed cosmetic vehicle. Behaviours and mechanisms underpinning the odour-masking activity remain largely undisclosed [1,2]. Further, it is not uncommon to identify conflicting results in the literature on this subject. However, the standard practice of adding a fragrance, in the attempt to adjust the odour profile of a formulation, often results in being only perceived as a single effect of a cosmetic or pharma formulation by the consumer [3]. Yet, when it comes to chemistry, it is usually one of the most critical additives of the formulation. It is even true that, depending on the specifics of target market profile of a formulation, adding a fragrance may not be regarded positively by the target consumer. Advancements have to be done to shed light on this topic. As stated above, odour-masking is part of a *sensory analysis* performed through different descriptive and analytical tools.

The sensory analysis commences by taking usage of descriptive methodology to evaluate the consumer acceptance of cosmetics, especially for products with topical use. The sensory analysis is thus the method of analysis used in cosmetic science to identify and quantitatively model the key drivers for a product's acceptance. Sensorial analysis data plays an integral role behind many marketing decisions. Whilst the results of the analysis can be reproducible on a larger scale, the complexity and high costs limit runs against the required, rapid pace of this industry. As a consequence of this, sensory data are more used in the field of research and development of new products, rather than the routine use in monitoring processes and quality control.

Although *sensory panels* and *consumer tests* for a common set of goods are leveraged to be a very powerful development tool in this realm, it is true that this set of tests presents pros and cons nevertheless. The sensory analysis usually provides a researcher with valuable data and insights for new research and marketing purposes. A whole comprehension of product variability stability, comparison to a competitor product, relationships to instrumental analyses and consumer understanding serves to raise the likelihood of product success. Many of the tests that are carried out are simple and straightforward to set up, whereas others are more complex and more require training and in-depth experience of the researchers. Ideally, the analysis of the odour-masking phenomenon is multistep by necessity. Firstly, different matrixes containing different concentration levels are evaluated through an olfactory method. Secondly, an *olfactory analysis* is performed as a result of the setting of study protocols to work toward outcomes of the first phase. In the domain of this specific project, specific adjustments were set for the ease of the project, and the author drafted a procedural scheme the point of reference. Moreover, the backbone of this project was realized through a series of biphasic matrices (samples), containing different investigated masking systems (solutions and dispersions). In other words, the experiential core of the project was predominantly run at a level of pre-formulation investigation. Supposed agents were tested by creating a battery of samples by using growing concentration ratios of investigated agents, with a ratio of 1:5, as a maximum. Sample preparations utilized a data set sourcing from the database of the R&D department.

Stability testing marked the other critical point of the project, and in general, stability process is the biggest hurdle of the development of a new concept. As a laboratory activity, stability testing can be a very financial burden. Yet, a more thorough understanding some of the technical aspects and criticalities is pivotal for the development of stable finished products in order to achieve commercial success. In practice, test design depends on product type and packaging. Numerous factors come into play in deciding when and what to test. The ultimate purpose of stability testing is to ensure that updated or newly launched products meet the indented physical, chemical and microbiological quality standards, functionalities and aesthetic appearance when stored under controlled conditions.

For cosmetics, it is even a cardinal guarantee for the consumer since cosmetics are supposed to not harm by definition. The European cosmetic regulation leaves a certain degree of freedom to the cosmetic manufacturer who is responsible to design its own stability testing procedure, but the product has to meet the specific requirements, maintaining stable properties for its shelf life. Therefore, the author considered lab data, in-house guidelines and raw material specifics as the study baseline of the project evolution. It is in fact common place in the industry that techniques need to be adapted and modified to the precise purpose of the study protocol. Theoretically, an appropriate flowchart of stability investigation should require a suitable number of investigative levels, depending on the complexity of the system.

As a rule of thumb, ingredients can have batch-to-batch colour variability which may be carefully managed. Also, trace metal contamination in the matrix can trigger to oxidize compounds causing variations of hue. Common and suggested test protocols include: light (UV, sunlight) exposure testing, centrifuge testing, accelerated testing, mechanical shock testing, temperature variations including freeze/thaw cycle. Furthermore, for all the above-mentioned tests, it is good practice to monitor and annotate data and observations in a lab notebook as a series of objective and detectable parameters.

Along the course of this project, these suggestions were followed yet adapted to the circumstances of these experiments and taking into account registered behaviours within the samples through the observational method. The core experimental research focused on simple chemical systems, such as solutions and dispersions. After the completion of the stability testing phase, a pre-selection of samples was identified and chosen to continue to run the body of the experiment. The following step was performed by a spray drying process of those matrixes which shown, apparently, the best match of properties. Bearing in mind this reasoning, and to either give it more credit or reconsider early-stage outcomes, the author regards an investigation via *SEM* and through the *E-nose* as recommendable to shed light on more scientific evidence [4].

Results

This section represents a brief overview of the main results in the graphs as follows:

The radar graph (Figure 1) shows a macro representation of a hypothesized odour-masking effect based on the series of empirical evidence and experimental results of this project. On one side, it could be argued that these sensory attributes do not represent the whole odour profile of investigated active ingredient. On the other, the absence of comprehensive literature, as well as the whole complexity of the chemical nature of the bio-active, has to be weighted as a factor. The evaluation scale of the background odour was determined and assessed as such: masked, not masked, modified and partially masked.

It must be noted that research studies have demonstrated that the brain process related to the taste and odour has a relevant degree of congruence between the two senses. So, the brain tends to twist cooperate in the formation of familiar sensory identities for the human being. This literature came in support of using a mixed terminology as sensory attributes (taste, odours) in the radar graph as such (see figure 1). Having said this premise, the author reported a distinct variation of the whole odour profile of the bio-active. This noticeable shift in sensory attributions was seen as an element to assume the modification of the background odour of the matrix because of the addition of the *pea starch*. Although the author found out a comparable effect (modification effect) with *maltodextrin* tested as an agent, however, it was not possible to graph all the results to showcase the overall effect in comparison to pea starch at this level of investigation [5,6]. Therefore, a further run of investigation may shed light on this hypothesized olfactive analogy. In must be kept in mind that, maltodextrins and pea search are chemically featured by the same molecules, albeit the two raw materials were sourced by two different plants by their respective manufacturers. Some of the differences in terms of chemical properties reported in the technical sheet give room to presume non-analogues effects.

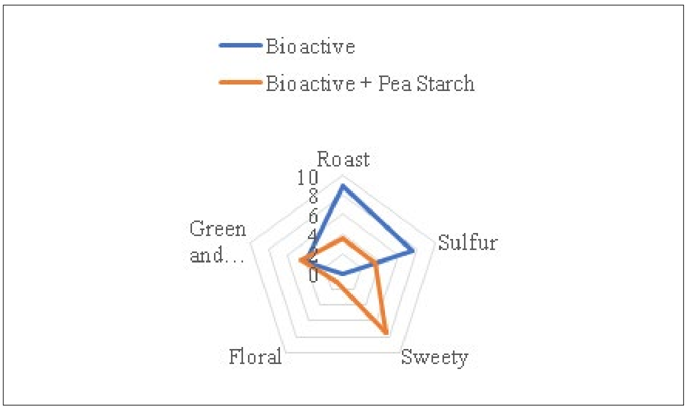

Figure 1. Olfactive analysis of the sample bio-active + pea starch.

In the case of *zeolite*, the author evaluated that there was diminishing tenacity of the background odour related to the bio-active after the chemical agent had been added. As a result of this, the optimal quantity to achieve the desired odour masking activity was found satisfactory with a ratio 1:5 (Figure 2). However, the supposed proportional relationship must be analysed and supported by further with instrumental measures. The main obstacle related to the use of this agent is related to its low solubility in water-like systems. Zeolite not only showed to have an impact on the appearance of the sample (dispersion) but also raised a reasonable concern about the potential hindrance of the whole bioactive bioavailability as a consequence of the high concentration of this chemical entity. In fact, the bio-active's capacity of freeing from this chemical once applied on the skin is a matter of concern.

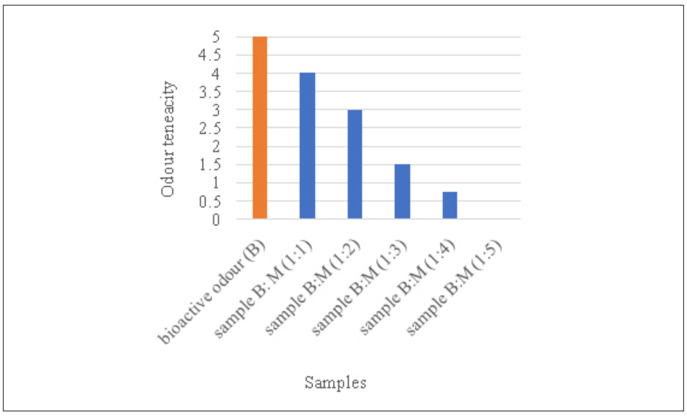

Figure 2. Olfactive evaluation of odour masking activity with zeolite (B: bio-active; M: masking agent).

The centrifugation test revealed that a degree of precipitation was found, yet minimal, in the test tube of each solution of the samples investigated. The presence of precipitate in the solution with the sole bio-active could be considered as to presence of impurities of the raw material. However, the complex solubility of the pattern of macromolecules of the bio-active brought up other stability-solubility questions. In light of the experiments conducted, the ratio precipitation had in samples with masking agents did not show a linear relationship. The author agreed that the least level of precipitation occurred both in the presence of a 1: 3 ratio of pea starch and maltodextrin (Figures 3 and 4).

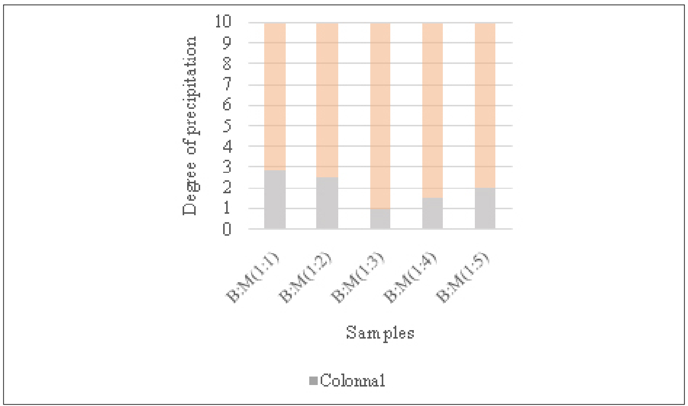

Figure 3. Precipitation degree in samples with maltodextrin (B: bio-active; M: masking agent).

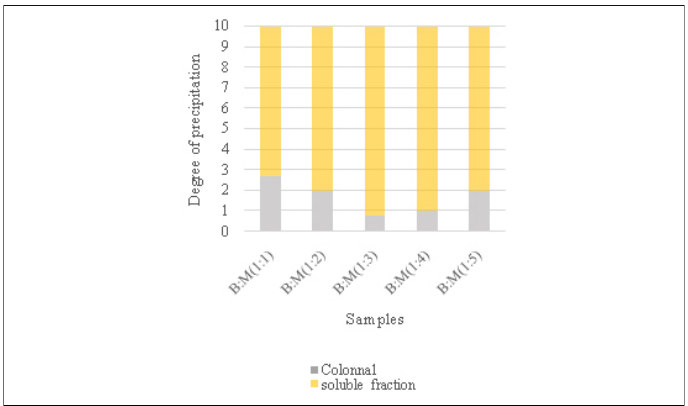

Figure 4. Precipitation degree in samples with pea starch (B: bio-active; M: masking agent).

Even though the agent β-CD (beta cyclodextrin) presumably showed partial masking activity, which was registered as a reduction of the intensity of the background odour, the high insoluble rate of this chemical forced to cast out this candidate from the experimental poll (Figure 5). Also, it was noticed that signs accelerated instability ended up altering the appearance of samples. Due to these reasons, samples with β-CD was phased out from the entire experiment set at this stage [7-12].

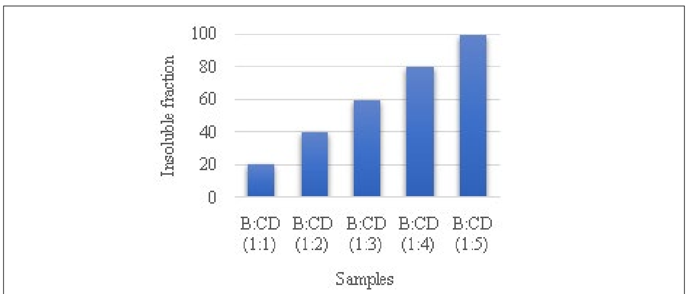

Figure 5. Precipitation degree with β-CD (B: bio-active; CD: cyclodextrin).

Conclusions

The main purpose of this study was to investigate potential, overall cost-effective and "unconventional" solutions to cover background odours of cosmetic raw materials [13-15].

The maltodextrins ended up serving as the ground for microbial proliferation. The cyclodextrins were phased out at an early stage of the experimental run due to lack of solubility as well as presumed incompatibility.

The optical observation trough microscope alone cannot allow broadening the scope of a plausible mechanism theory in the case of maltodextrin-based samples without tapping into speculation. However, this outcome was expected by the author. Nevertheless, it is plausible to theorize the correlation of the formation of a chemical complex between the range of molecules, which are responsible for background odour of the bioactive and maltodextrin-like substances behind the manifestation of this effect. Overall, systems containing zeolite revealed better results in terms of odour-masking activity. The microscopical analysis of the spray-dried sample seemed to suggest the formation of a superficial adsorption.

With regards to pea starch, this chemical ended up changing the characteristic odour profile of the solution containing the bio-active already dissolved.

This chemical belongs to a new generation of ingredients, which is currently widely used. Pea proteins and derivatives, for example, are gaining momentum as a result of interesting properties of the whole plant.

As opposed to zeolite, pea starch showed great solubility in all samples in water, although increasing precipitation was noticed after the centrifuge test had been run on the samples with a ratio 1:4 and 1:5.

Therefore, it is suggestable to see the potential innovativeness of this ingredient to stimulate further ad-hoc appraisals.

The results of the spray drying stage demonstrated that any background odour was not perceivable with regards to zeolite-based samples, after the run of this technical process. With the case of maltodextrins and pea starch, the odour of the active ingredient was bearably perceivable.

Suggestions

The matrix with cyclodextrin inside, although it showed an odour masking activity similar to zeolite, it was discarded at the beginning of the experience due to its strength biodegradability shown through the emanation of a strong "rancid" odour already after 24 hours and quick changes to the surface appearance.

In summary, a thorough physical-chemical characterization of hypothesized chemical complexes is still recommendable.

The chemical class of zeolites is gaining strong interest from the scientific world. Through small structural modification processes (e.g. ion exchange processes) it is possible to obtain substances with some physical-chemical properties modified with a high application potential [16-18].

Finally, efficacy, safety and sensory characteristics should be equally weighted to meet needs of ever-demanding, savvy consumers.

Role of Sponsor

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