THE IMPORTANCE OF THE ORGANOLEPTIC ANALYSIS IN WAXES, PARAFFINS AND MIXTURES FOR THE FOOD INDUSTRY

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1. INTRODUCTION

The organoleptic analysis of a substance or food is a subjective test that directly involves taste and smell. For Waxes, Paraffins and other mixtures, taste does not apply, so in this report will be focused only on the organoleptic properties of these substances that is perceived through our nose and analysed and studied by the sense of smell.

In this sense, it is extremely difficult to talk about something you don't see, you don't hear, you don't know or you can't touch. Our faithful friends the dogs, contrary to what happens to humans, interpret reality and environment by using their nose, then, by the eyes and finally by hearing (or at least, that is what is believed until now…)

In **2004**, **Richard Axel and Linda B. Buck were awarded with** the **Nobel Prize in Medicine because of** their discoveries regarding odour receptors and the organisation of the olfactory system. According to Axel and Buck's findings, most odours are odoriferous molecule complexes, each of them activating several smell receptors. This provokes a cascade of biochemical reactions that allow us to recognize and memorize ***about 1.000 different odours.***

Ten years later, in **2014**, further studies and experiments endorsed by prestigious scientists showed that the sense of smell could be more acute than expected and that a human nose can distinguish among more than ***a billion various aromas.***

This fact suggests that not even the human eye would have as much ability to detect colours as the olfactory system to identify smells.

In **2017,** neuroscientist John McGann, from the **Psychology Department of Rutgers-New Brunswick University (New Jersey, U.S.A.)** studied the sense of smell and reviewed all scientific publications on the subject for more than 14 years assuring that "our sense of smell is as sharp as a dog's and rodent's", the finest sniffers in the animal kingdom. The fact is that the approach is different: we can detect dozens of aromas in a good wine just like a hunting dog can follow the trail of a hare by its urine molecules. Our knowledge of the sense of smell is rather based on an "old tradition" and on "ill-founded studies", said McGann, who proposes that a better knowledge of the same could be useful for the diagnosis of aging-related diseases such as Alzheimer's

In **2019**, scientists from the **Chemical Senses Center of Philadelphia** and the **New York University College of Dentistry**, discovered functional olfactory receptors in a place used to be a bastion of the sense of taste: the tongue.

According to these experts, the simple explanation is that while the taste cells evaluate the nutritional supply of food, the smells receptors present in the taste buds would detect volatile compounds. Thus, the relationship between taste and smell is closer than previously believed.

Despite all these studies, investigations into the sense of smell are decades behind if compared to the studies on vision or hearing, with less attention and funding.

The reason may be the tremendous complexity that scientists face when they try to unravel the scented chemicals taken in through our nose and the subsequent interpretation of those signals made by our brain; the vision requires the participation of 4 types of receptors, 40 ones are involved in the taste but in the sense of smell there are more than 350

2. THE CHEMISTRY OF SMELL. WHAT THE SMELL IS

The odour, from a chemical point of view, is a perception resulting from the reception of a stimulus by the olfactory sensory systems due to an interaction between an organic substance and the olfactory receptors. These chemoreceptors are responsible for collecting odourous molecules that previously had to pass to a gas and vapour complex phase. There are usually low molecular weight chemicals, although there are exceptions such as the steroids, which, although higher in molecular weight, also provoke this stimulation. Some scientists believe that the smell is such as personal, single perception that it cannot be measured. Certain areas of our brain (as the limbic system, linked with emotional state of a person) are the ones aiding to classify an aroma as pleasant or unpleasant.

Let's take a clear example: when a person is hungry, and cooks, there is a very pleasant perception about the food. But this perception may become unpleasant after having eaten.

Odour perception is therefore subjective and combines various aspects such as odour intensity, odour quality, etc.

Here are some very important concepts to consider in order to understand the chemistry of smell:

Odour concentration: that's the number of odour units per unit of volume.

Odour threshold: It is the sensitivity of our smell to an olfactory stimulus, expressed as the concentration of a gaseous substance in $\mu g/m^3$ which will be perceived as different to the odourless air by (at least) the half of the population. By definition, this concentration is 1 unit odour/m^3. In other words, it is the minimum concentration of an odourific stimulus capable of provoking a response in our smell.

Odour standard: it is an odour limit, expressed as the maximum concentration which cannot be exceeded.

Zero effect level: It is the highest possible concentration of odour that a population will not perceive as unpleasant.

Intensity: It is the strenght of perceived sensation.

Alghought hard to believe, there is a unit called **olf** to measure that intensity, which is equivalent to the aromatic emission from an adult individual who takes a shower for 0.7 times, changes underwear every day, and usually sits when doing the daily activities.

Quality: It is the differentiating character and resemblance degree of an odour. It allows to describe and differentiate qualitatively different odours.

Acceptability: it is a subjective characteristic of each person, associated to talk about pleasant or unpleasant odours.

The chemical structure of hundreds of odours is currently known, as most of them are catalogued as **scents or fragrances** by the the food, cosmetics and perfume industries.

3. THE SENSE OF SMELL

With every breath, our brain receives messages from the surroundings. Whether it's a flower or a spooled food, our nose picks up and records its aroma and transmits it to our brain at the speed of light.. This happens every minute, every hour, day and night and is so important that it can save our lives...

Smelling's a key during breastfeeding: when a baby has not yet developed his vision, taste or touch yet, he already has a powerful smell that helps him to know who his parents are at all times.

Thus, we are each, individually, a world...of smells. Our body odour is determined by a unique composition of fatty acids present in our skin, result of the bacterial activity in our sebaceous glands and whose cutaneous microflora is controlled through the genes of our immune system.

The sense of smell is vital for many living beings and almost essential for mammals and their relationship with the environment, either for looking for food, identifying hazards or for courtship and mating relationships, where the smell is crucial. But these decisive odours, key for the survival of a species, represent a tiny amount in the world of odours.

In addition, our sense of smell is one of the most sophisticated systems through which a person can capture the external environment, reaching the point of being able to modify our behavior and our emotional state just with that we smell: In short, and drawing food on example, everything that does not flow through the nose, neither comes in at the mouth.

The Origin of the Smell

The brain stem is at the top of the spinal cord and it can be said that this primitive brain is the one we share with species with a rudimentary nervous system. This manages basic activities such as breathing and metabolism of some organs, it is responsible for performing the basic programmed tasks for the maintenance of the body and ensuring its survival.

This is the brain of the Age of Reptiles "the reptilian brain", in which a cluster cell to record and analyze odours was developed: the **olfactory bulb.**

In those ancient times smell was an essential sensory organ for survival since every food, poison, sexual partner, predator or prey has its own, characteristic molecular identity that can be carried by the wind and recorded by a nose.

When the first mammals appeared on Earth the olfactory centre was composed of a few, primitive neural layers specialized in odour analysis.

These later evolved by surrounding and enveloping the brain stem into rings, then generating the limbic system and providing these protomammals with two powerful tools: **learning and memory**, two key advances in survival since they would allow the adaptation to the environment in a more intelligent way and not relying solely on predetermined, unhelpful automatic responses when making decisions, at the moment of making a difference, recognising and comparing odours.

Millions of years later the evolution of the limbic system led to the development of the thinking brain or neocortex.

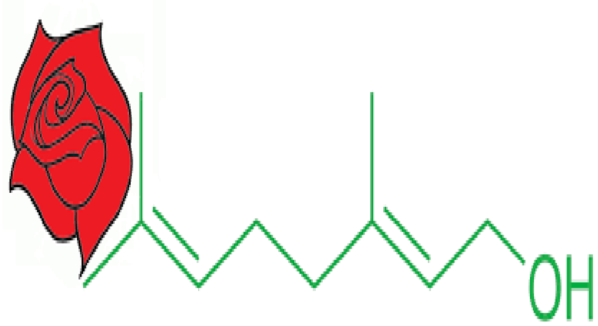
Thus, our emotional brain is intimately linked to the sense of smell than the rational one.

How does our sense of smell work? It has been shown that nose olfactory cells are not the only ones able to record odours, but they are the precursors of a cascade of "electrical information" through the neural networks of the olfactory system. Active genes encoding for odour-receiving proteins have been found in such as unexpected body parts as the tongue, kidneys, large intestine, or testicles.

Humans have more than 350 types of receptor proteins in nose olfactory cells which capture the chemical composition of odour and translate sensory impressions into electrical signals.

The generation of a nerve impulse in response to a molecule capable of producing an aroma is the result of a voltage variation in the cell membrane caused by alteration of AMPc or Inositol 3P levels. It is, therefore, a series of experiences dependent on brain functioning that always operates through messages between neurons.

When we smell a rose, our sense of smell faces a combination of more than 500 aromas, but only one, the *Geraniol,* evokes the rose odour on its own. The brain is responsible for extracting the main sensory data from the stream of incoming signals It values and connects them to previous experiences, (what is called **olfactory memory**). Subsequently, the olfactory cortex classifies the sensory impressions received by categories according to their respective chemical properties. But before the neural network of the olfactory cortex processes the odourous signals, events have already happened.

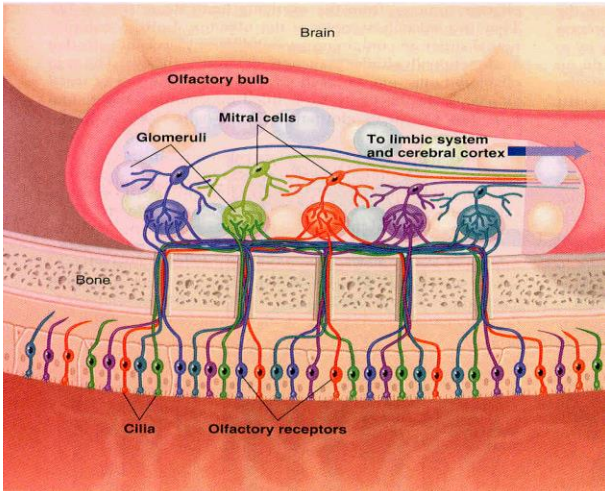


Olfactory cells register a fragrance of smell; then, the odours are redirected for further analysis to the **olfactory bulb** where the nerve endings of the sensory cells top off and connect with mitral cells (mitral-shaped neurons) activating a battery of the same. These contact zones resemble small spherical structures, **the glomeruli**, which constitute the first processing stage for flavourings.

Each of these bulb switching elements conveys a fragment of incoming information. Thus, the neural code of an aroma is not reflected in a pattern of isolated neurons, but it is the result of the coordinated activity of numerous mitral cells giving rise to the so-called **population code**. These population codes, when associated with substances of notable chemical kinship, closely resemble to each other and are strongly correlated.

The olfactory bulb works like a **tilting switch.** When the concentration of two similar flavourings in a mixture is modified, the neural activity pattern suddenly changes. Related chemicals, as well as the same substance but in a different concentration, can cause a similar neural activity map.

The olfactory bulb, in addition to managing odour mixtures discards (depending on the mixture), one of the odourous substances in the population pattern initially shared by two substances. This would be the explanation to the smell of the rose for which we only capture a couple of aromas, among the several hundreds it has. In the case of combinations of distinct odourous substances, the neural network can create a new aroma from two substances.

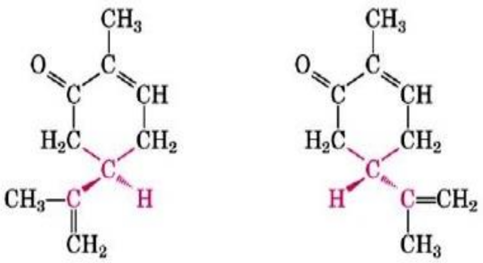


The Principle of Generalization and Separation Theory seems to reveal in this processing the way in which the olfactory bulb simplifies the torrent of odourous information that accesses to our brain. The neural network of the olfactory bulb works through both mechanisms: it can distinguish or generalize, as necessary.

In the case of the same odours with different concentrations, the olfactory cortex must ignore dissimilarities of activity patterns by generalization method; only in this way two different sensory impressions can be identified as equal. This happens when a substance with different concentration (which we initially perceive as equal or similar) smells different when its concentration is increased.

One example is mercaptomethylpentanone, which in high concentrations gives the wine a blackcurrant aroma, but in other concentrations evokes cat urine.

For chemicals with a similar structure, the olfactory cortex must separate the related signals in order to evaluate these stimuli as different. The stereochemistry of odour molecules would be the answer, the relationship of three-dimensional structure of the molecule and its electronic character (electron distribution).



(*R*)-carvone (peppermint) (*S*)-carvone (caraway)

4. WHAT DOES WAX SMELL LIKE? ODOUR ASSESSMENT IN THE PETROCHEMICAL INDUSTRY. ASTM D 1833-87 STANDARD

The answer to this widespread question would revert to another one: what does the beeswax smell like. Beeswax (*Apis mellifera*) is a complex mixture of more than 300 single components including fatty acid esters, fatty alcohols, saturated and unsaturated hydrocarbons

This production takes place in a cell complex called "wax glands" and whose secretion is a constant process beggining from the first week of a worker bee's life .

For our nose, the result of this chemical complex is just a, bit or less intense smell. But beeswax scent would be easily differentiated in an organoleptic tasting among many others.

But industries engaged in the manufacturing of waxes actually produce mixtures, and in many cases, most of these ones are based on petroleum waxes such as micro and macrocrystalline paraffins.

The name *paraffins* refers to saturated hydrocarbons obtained from the vacuum distillation of petroleum and the subsequent refining stages to which fractions or cuts are subjected in order to obtain lube oils.

From a chemical point of view, these are alkane mixtures where linear carbon chains with lengths between C20 and C60 (n-paraffins) predominate in a mixture with branched chains (isoparaffins).

The ASTM D1833-87 Standard (Test Method for Odour Petroleum Wax) is a standardized procedure to measure the odour intensity of such hydrocarbon mixtures. For some uses of this type of petroleum waxes (food coatings & additives), odour intensity is a very important characteristic.

This method classifies the odour of waxes according to their intensity, using a numerical scale (see table) instead of descriptive terms, without taking into account either the quality or the type of odour.

Numerical scale	Odour description
0	Odourless
1	Light
2	Moderate
3	Strong
4	Very strong

The Standard is primarly based on the fact that a number of judges organoleptically value independent samples and assign them a numerical value corresponding to the abovementioned scale.

Judges should not discuss the odour test results until the analysis of all samples has been completed.

The average rating of the numerical data provided by the judges is established as the odour rating for the sample. Thus, what is actually assessed in the odour tests of the products manufactured in these industries, are complex mixtures of hydrocarbons, oils, resins, polymers and a long etcetera of chemical compounds treated with sophisticated filtration, refining, percolation and deodourization methods. which give rise to compounds or final products with a characteristic and unique odour for that product, which will be more or less pleasant, or intense depending on the olfactory sensitivity of the analyst responsible of this complicated task.

5. FOOD SAFETY & THE IMPORTANCE OF ODOUR TEST FOR WAXES, PARAFFINS AND PREPARATIONS FOR THE FOOD INDUSTRY

The latest trends from the food industry world are dominate by a great technological progress, together with a society of informed consumers which are made aware of all food safety events. This causes a greater awareness of the risks associated with food production and control techniques.

These factors make food control, from raw materials to the final product, increasingly necessary. The emergence of regulations whose compliance guarantees the consumers the quality and safety of products is growing.

Other application of wax-based products in the food industry is that of a food additive, to be directly included in the formulation of the final product (for example, microcrystalline waxes represent a quite important proportion in the gum base used for the production of chewing gum) or as coating wax in direct contact with foodstuffs (i.e. cheese).

This application involves a series of fundamental properties for the protection and preservation of the cheese against contamination by microbiological, climatological or thermal agents.

In addition, they give it sealing, mechanical resistance, flexibility and uniformity among other properties.

But it does not seem sufficient to have a technically perfect product in these aspects, if its organoleptic properties are not adequate.

The importance of the odour in these waxy products is critical; so much so, this organoleptic parameter can be responsible for the direct rejection and non-conformity by a customer when receiving the goods. Certainly, it can't be otherwise. Being by-products from the cracking and refining of petroleum crude oil, these give waxes and paraffins a characteristic odour which is determined by their chemical composition. In fact, the smell of a food is an indicative of its safety since an unpleasant smell it's always associates with a food in poor condition and dangerous for health, even if it is not. Therefore, the raw materials that compose it must have that same safety standard and the smell is a definitive parameter to interpret the product quality.

Food safety systems, increasingly present in non-food industries (engaged in the manufacturing of food additives or technological processing aids) and regulations related to food additives are getting more stringent and restricticve in all its field, so that they require the same safety for the innocuity of that raw material or additive as for the final product (food) placed on any shelf in a supermarket.

We proceed on the basic, legal obligation principle that all foodstuffs present in the market are safe for the consumer, following **Codex Alimentarius, Food Safety White Guidelines as well as HACCP Plans and Prerequisite Programmes.**

But we can find different qualities and presentations between food products of the same category. For this reason, there are voluntary food safety and quality programmes to provide added value to one or other.

Among these unsolicited Standards two ones stand out: **ISO 22000 and FSSC 22000** certifying industrial processes to ensure food safety. Other regulations from a private origin and regional application include German **IFS (Internacional Food Standard)** o British **BRC (British Retail Consortium)**. And they all exist with only one objective: they try to demonstrate the ability of an organization or a company to identify risks that can affect food safety.

6. QUESTIONS AND CONCLUSIONS

Human smell sense has been, up to date, one of the least appreciated ones, maybe by ignorance; but the fact is that new findings and research show it as a very powerful sensory instrument. We have a very good nose, better than we would think because, with its 350 types of receptor proteins, encoded by around 1000 genes far exceeds the 4 of color vision and the 40 ones for the sense of taste.

Our sense of smell was developed for our adaptation to the environment and evolved to differentiate very similar odours and aims to discern if a food is good or bad just by its aroma. Our brain and olfactory memory economize to the maximum all this type of relations with the external environment. It would not make much sense, (either physiologically or physically), to have one receptor for each odorous substance,

It would be a waste of energy and space. For this reason, signals must be filtered to keep the most relevant tones.

Our emotional brain was cemented and developed on the structure that controls our sense of smell and more precisely, on the olfactory lobe, hence the close relationship between smells and emotions. Its influence on human behaviour is much more important than believed since smells arouse emotions, memories, perceptions: all this thanks to the olfactory memory

Even the ASTM D1833-87 standard is not clear and effective in assessing the smell of a wax, since this standardised method is based on the odour intensity criteria, totally ignoring its quality, when it has been shown that our brain does not work like this. The validity of these odour tests for a demanding future at the food sector is highly questionable; this distrust may be due to the tremendous subjectivity of an individual odour assessment through an ASTM Standard and that the olfactory centres are intimately connected to our brain's memory and emotion ones, being the smell perception a "manipulable" capacity by our feelings or state of mind.

The Food Industry's need to ensure safe food to its customers can only further increase organoleptic and quality requirements for manufacturing suppliers of these wax additives, paraffins and preparations. The use of technological equipment for the odour determination shall be required and efforts should be focused at automating and analysing this parameter with physical detectors of organic compounds capable of carrying out qualitative and quantitative analyses of a mixture of gases, vapours and odours.

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