M.A.R.S.™ — MICRO ALCOHOL REACTION SYSTEM

Physicochemical basis, experimental activity and technological benefits investigated in hydroalcoholic matrices

ND Pharma & Biotech Co. | INTABIOTECH S.L.

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Micro-reaction science for precision spirits

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Summary

M.A.R.S.™ (Micro Alcohol Reaction System) is a technological development by ND Pharma & Biotech based on the application of a microreaction system to hydroalcoholic matrices. The technology was conceived to modify specific physicochemical properties of alcoholic beverages, study the consequences of this intervention on their experimental behavior and explore opportunities to optimize their organoleptic characteristics.

The system is based on an aqueous organo-mineral formulation, consisting essentially of mineral substances and high-purity food-grade sodium and potassium salts, prepared using a specific technological procedure.

The original research examined the action of the system in three areas of interest: transformation of the hydroalcoholic medium, changes in oxidation-reduction properties and evaluation of specific biochemical responses associated with experimental exposure to ethanol.

The original technical publication, prepared by José M. López and colleagues and dated 2011–2012, includes comparative studies in a Sprague-Dawley animal model, assessing the time course of blood alcohol concentration, oxidation-reduction potential, reactive oxygen species and various parameters of ethanol metabolism.

These studies form the experimental foundation of a technological platform whose industrial relevance extends to the preparation, formulation and finishing of distillates and spirit drinks.

1. Nature and basis of the technology

The M.A.R.S.™ system was developed through the study of hydroalcoholic matrices as multicomponent systems in which ethanol, water and dissolved substances participate in a dynamic equilibrium of physicochemical interactions.

A spirit drink is not merely a mixture of water and alcohol. Its behavior also depends on the concentration of volatile compounds, organic acids, esters, aldehydes, higher alcohols, phenolic substances and other components that influence both its stability and its organoleptic perception.

> The original technological concept of M.A.R.S.™ was formulated in terms of alcoholic microreaction and microfragmentation, associated with an intervention in the organization of the hydroalcoholic matrix and the properties of the medium.

1. Nature and basis of the technology

The development hypothesis proposes that incorporating the organo-mineral composition under specific conditions may modify certain properties of the system, including those related to its acid-base behavior, oxidation-reduction state and sensory characteristics.

From the perspective of solution chemistry, interactions among ionic species, water molecules and organic compounds provide a framework for investigating solvation phenomena, molecular association and interfacial behavior. These considerations enable the study of potential changes in the hydroalcoholic system, while the precise nature of the postulated transformations requires corresponding experimental characterization for each product in which the application is intended.

The original evaluation of M.A.R.S.™ focused particularly on observable changes in redox potential and specific comparative biochemical responses.

2. Composition and characteristics of the reaction system

ND Pharma & Biotech's technical and regulatory documentation from April 2019 describes M.A.R.S.™ as a preparation consisting essentially of high-purity food-grade salts and mineral substances, concentrated and supplied as an aqueous suspension.

The use of mineral components reflects the concept of a technologically active formulation, designed to act on the hydroalcoholic medium through a specific preparation procedure.

The development is based not only on the individual identity of the substances incorporated, but also on their formulation, the conditions under which the system is produced and the reaction they induce in each matrix.

In this regard, mineral composition, concentration, dispersion state and the physicochemical conditions of the medium are relevant factors in studying its behavior.

The original formulation proposes a multifaceted technological intervention, encompassing modification of the properties of the hydroalcoholic system, study of its acid-base and redox behavior and optimization of its organoleptic characteristics.

3. Investigation of oxidation-reduction potential

Measuring redox potential with laboratory rigor.



3. Investigation of oxidation-reduction potential

3.1. Basis of the parameter

Oxidation-reduction potential, commonly referred to as ORP (*Oxidation-Reduction Potential*), is an electrochemical parameter used to characterize the behavior of a medium with respect to specific equilibria between oxidizing and reducing species.

In hydroalcoholic systems, the measured potential may depend on chemical composition, pH, redox-active components and measurement conditions.

Its study provides a means of characterizing the physicochemical changes produced by an intervention in the matrix.

3. Investigation of oxidation-reduction potential

3.2. Originally reported results

The M.A.R.S.™ research included comparative measurements of redox potential in treated and untreated alcohol samples.

According to the original publication, under the experimental conditions for untreated alcohol, redox parameter values above +500 were recorded on the scale used by the authors.

By contrast, in samples subjected to M.A.R.S.™ treatment, the document describes a decrease in the value to approximately +100, with the observed behavior subsequently maintained throughout the study period.

This difference represents one of the most notable physicochemical findings of the initial research. Its technological significance lies in the system's ability, according to the reported results, to produce a measurable change in the electrochemical state of the treated matrix.

The original research linked this phenomenon to the oxidative behavior of the system and its potential influence on other variables studied.

3. Investigation of oxidation-reduction potential

3.3. Relevance to the beverage industry

Redox potential can be used as a complementary parameter to characterize treatments and study the physicochemical stability of specific formulations.

In complex spirit drinks, oxidation-reduction equilibria are linked to numerous processes affecting the evolution of aromatic substances, phenolic compounds and other components capable of participating in oxidation reactions.

The electrochemical activity described for M.A.R.S.™ therefore offers a specific line of research for the finishing and specialized conditioning of alcoholic beverages. The value of this parameter lies particularly in its capacity to be measured and compared using standardized analytical procedures.

4. Comparative studies of blood alcohol concentration and ethanol time course I

4.1. Experimental model

The original publication describes an experimental program conducted on a total of 15 animals of the *Sprague-Dawley* strain.

Different alcoholic preparations were administered by gastric perfusion, and various biochemical and ethanol exposure variables were studied over successive time intervals.

The comparative conditions included untreated alcoholic preparations and preparations subjected to the M.A.R.S.™ microreaction system.

The parameters examined included the time course of blood alcohol concentration.

4.2. Reported results

In the untreated alcohol group, the authors observed that blood alcohol concentrations were maintained during the first few hours, with decreases reported mainly from the sixth hour onward and during the subsequent follow-up period.

For preparations treated with M.A.R.S.™, the publication reports a different temporal pattern.

4. Comparative studies of blood alcohol concentration and ethanol time course II

4.2. Reported results

The authors described blood concentrations below those observed under the reference conditions and an appreciable decrease from the third hour onward, with a more pronounced decline from the fifth hour of the experiment.

The comparison was presented graphically using time-course curves of the experimental variables.

4.3. Experimental significance

These results established the time course of blood alcohol concentration as one of the main criteria for investigating the system.

The temporal comparison allows examination of ethanol exposure following administration of treated and untreated preparations.

From a pharmacokinetic perspective, differences between concentration-time curves are relevant to studying phenomena related to the absorption, distribution and elimination of the compound (from the alcoholic beverage).

The historical M.A.R.S.™ research specifically highlighted the relevance of studying the experimental behavior of ethanol following technological intervention in its administration matrix.

5. Research on reactive oxygen species

Molecular research with analytical precision.



5. Research on reactive oxygen species I

5.1. Significance of ROS

Reactive oxygen species, known by the acronym ROS (*Reactive Oxygen Species*), comprise various chemical entities involved in biological oxidation processes and cellular signaling.

Ethanol metabolism involves several enzymatic pathways, including alcohol dehydrogenase and the microsomal system associated with CYP2E1.

The activity of these pathways may be associated with changes in cellular redox balance and the generation of oxidizing species.

For this reason, ROS assessment is a variable of interest for characterizing experimental responses associated with alcohol exposure.

5. Research on reactive oxygen species II

5.2. Results of the M.A.R.S.™ study

The original publication included comparative measurements of the time course of ROS following alcohol administration.

Under the untreated alcohol conditions, a decrease in ROS generation was described from the sixth hour onward, less pronounced than that reported for the treated experimental group.

Under the M.A.R.S.™ conditions, the authors observed a relative peak in ROS generation between the second and third hours.

A pronounced reduction in values was subsequently described, particularly from the sixth hour of the experimental period onward.

The reported temporal pattern was a relevant finding of the study, showing differences in the time course of oxidative variables between the two experimental conditions.

5.3. Biochemical significance

The inclusion of reactive oxygen species markers extended the research beyond the study of blood ethanol concentration.

The study thus simultaneously addressed alcohol exposure variables and parameters related to the oxidative behavior of the experimental organism.

Comparing both classes of variables provided an integrated approach to studying the biochemical responses associated with formulations treated using M.A.R.S.™.

6. Evaluation of alcohol dehydrogenase and aldehyde dehydrogenase I

6.1. Metabolic basis

Alcohol dehydrogenase (ADH) and aldehyde dehydrogenase (ALDH) are involved in two of the main stages of oxidative ethanol metabolism.

The former participates in the conversion of ethanol to acetaldehyde:

$$CH_3CH_2OH + NAD^+ \rightarrow CH_3CHO + NADH + H^+$$

The latter is involved in the subsequent oxidation of acetaldehyde to acetate through an NAD^+-dependent reaction.

Both pathways are fundamental biochemical reference points for the experimental study of alcohol metabolism.

6.2. Variables investigated

The original M.A.R.S.™ research included measurements of type 1 alcohol dehydrogenase and aldehyde dehydrogenase at different time intervals.

The results were presented in comparative graphs showing the time course of both variables.

The inclusion of these indicators enabled the study of enzymatic systems directly related to the metabolic processing of ethanol and its main intermediate metabolite.

6. Evaluation of alcohol dehydrogenase and aldehyde dehydrogenase II

6.3. Findings of interest

The figures in the study show different temporal profiles across the experimental groups for both alcohol dehydrogenase and aldehyde dehydrogenase.

The study of both enzymes was linked to the observed differences in the time course of blood alcohol concentration and to the complementary analysis of hepatic parameters.

From a research perspective, one of the most important aspects of this approach is that enzymatic variables were considered together with blood ethanol concentrations and oxidative parameters.

This enabled an integrated experimental approach to the system, simultaneously considering exposure, metabolism and biochemical response.

7. Evaluation of hepatic markers

The research included references to measurements of aspartate aminotransferase (AST) and alanine aminotransferase (ALT), two enzymes commonly used to study the hepatic biochemical response.

The publication compares treated and untreated conditions and reports differences in aminotransferase levels during the 24 hours following alcohol exposure.

The graphs in the original publication present reference values for these markers under the experimental conditions studied.

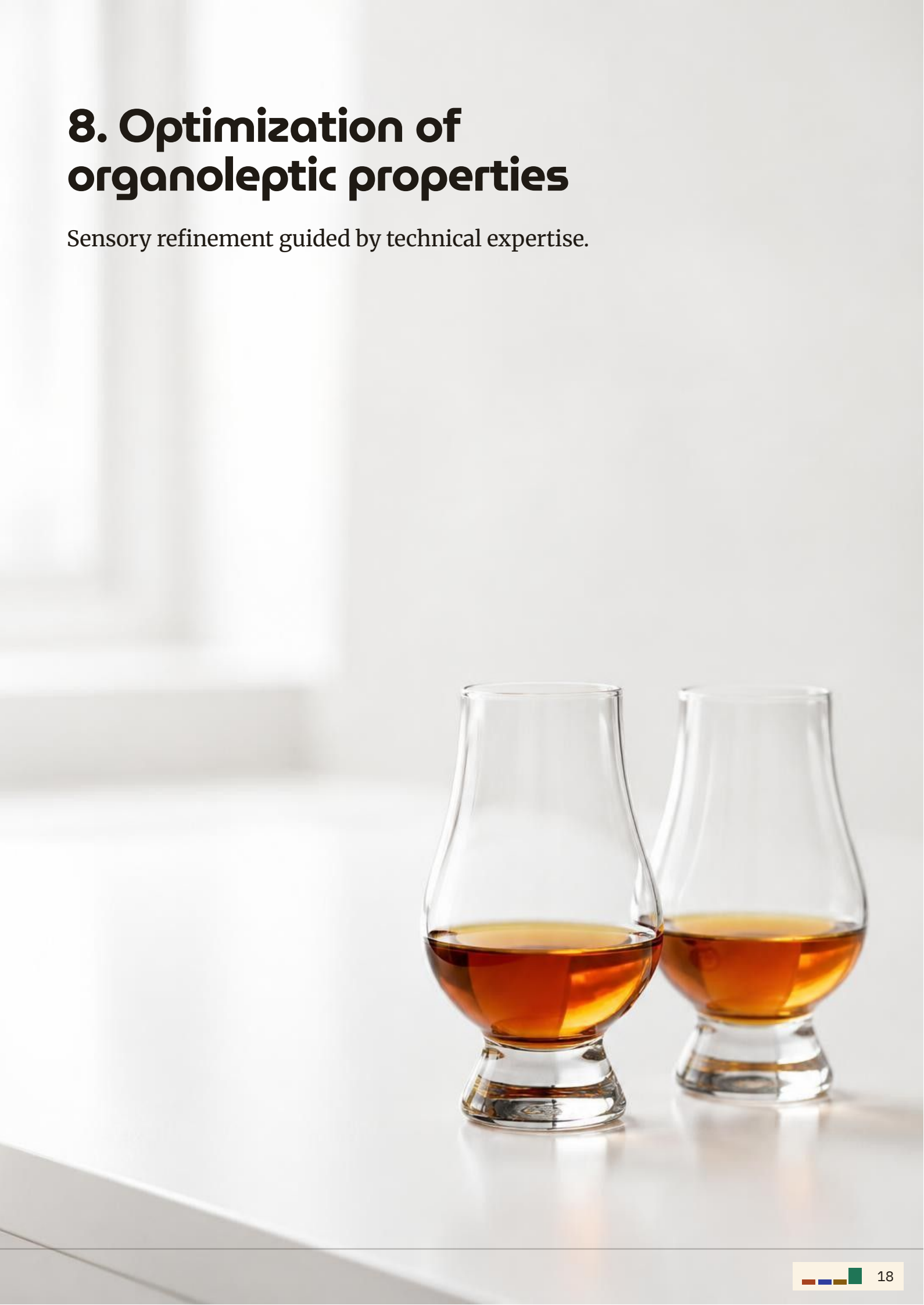
The authors interpreted the results as part of a set of favorable observations in animals that received preparations previously treated using M.A.R.S.™.

The significance of this line of research lies in its incorporation of hepatic response parameters into the comparative study of alcoholic preparations.

The combined assessment of transaminases, ethanol-metabolizing enzymes, blood alcohol concentration and reactive oxygen species broadened the biochemical scope of the original experimental program.

8. Optimization of organoleptic properties

Sensory refinement guided by technical expertise.



8. Optimization of organoleptic properties I

In addition to the preclinical studies, the original development of M.A.R.S.™ expressly envisaged improving the organoleptic characteristics of alcoholic beverages.

This objective represents one of the main technological applications of the system in the spirits sector.

The sensory properties of a spirit drink result from interactions among ethanol, the components of the aqueous medium and the substances responsible for its aroma, flavor, texture and persistence.

In this context, the research and application of M.A.R.S.™ focus on several aspects of interest.

8.1. Perception of alcoholic intensity

The initial alcoholic impact is a relevant sensory characteristic in numerous categories of spirit drinks.

Improving the integration of the alcoholic component may promote the perception of a more balanced product, without necessarily equating this improvement with a reduction in its alcoholic strength.

M.A.R.S.™ was conceived to explore this type of sensory modification through its intervention in the hydroalcoholic matrix.

8. Optimization of organoleptic properties II

8.2. Balance of aromatic components

Aromatic balance depends on both the composition of the beverage and the release and perception of its volatile substances.

The sensory integration of alcohol with the other components offers a promising avenue for developing spirits with more harmonious organoleptic profiles.

The technological application can be examined through comparative sensory evaluations of treated and untreated samples.

8.3. Texture, body and persistence

The original publication includes improvements in texture and palate among the system's objectives.

These characteristics include tactile perception in the mouth, initial alcoholic intensity, the balance of sensations and product persistence.

Their study is of particular interest in aguardientes, young spirits, hydroalcoholic bases and formulated spirit drinks.

8.4. Technological refinement

Developing systems that enable intervention in the sensory behavior of alcoholic beverages offers opportunities to improve preparation and finishing operations.

In this context, M.A.R.S.™ can be studied as a complementary formulation and conditioning technology, with particular relevance to achieving defined and reproducible sensory profiles.

9. Integration of the benefits investigated

The original M.A.R.S.™ studies identify several interrelated areas of research.

The scientific value of the original research program lies in its multifaceted approach, considering physicochemical variables and biochemical parameters together rather than studying a single characteristic in isolation.

This approach identifies several lines of work that can be developed through specific analytical studies, both in hydroalcoholic matrices and in experimental models.

Research area	Reported observation or application
Redox potential	Decrease in reported values in treated samples compared with untreated conditions
Blood alcohol time course	Temporal differences in blood concentration, with earlier decreases in the treated group according to the authors
Reactive oxygen species	Changes in the temporal ROS profile in the experimental model
Alcohol dehydrogenase	Determination of enzyme profiles during follow-up
Aldehyde dehydrogenase	Evaluation of enzymatic responses related to acetaldehyde metabolism
Hepatic markers	Comparison of aminotransferases across experimental conditions
Organoleptic characteristics	Objectives of smoothness, texture, alcohol integration and sensory balance
Industrial application	Study of formulation, conditioning and finishing processes for alcoholic beverages

10. Relevance to spirit drink technology

From microreaction to the glass: industrial relevance.



10. Relevance to spirit drink technology

In the spirit drinks industry, the physicochemical composition of a product determines its stability, organoleptic characteristics and behavior during manufacturing operations.

The M.A.R.S.™ research provides a technological foundation for exploring interventions in the hydroalcoholic matrix using mineral formulations specifically designed for this purpose.

Applications of interest include conditioning alcoholic bases, sensory optimization of spirits, development of formulated beverages and investigation of complementary finishing treatments.

Analytical characterization of these applications may combine electrochemical measurements, stability studies, volatile compound analysis and comparative sensory evaluations.

The selection of variables depends on the technological purpose of each intervention and the specific properties of the product.

From this perspective, M.A.R.S.™ represents a research and technological development platform with two distinct and complementary dimensions: physicochemical research into hydroalcoholic systems and evaluation of their industrial applications.

11. Conclusions

The development of M.A.R.S.™ represents prior technological research focused on intervention in hydroalcoholic matrices using a specific mineral-composition system.

The original documentation identifies experimental findings regarding the redox behavior of treated preparations and describes differences in the time course of specific metabolic and oxidative variables in the animal model studied.

Notable reported findings include changes in oxidation-reduction potential, differences in blood ethanol concentration curves, the time course of reactive oxygen species and observations relating to alcohol-metabolizing enzymes and hepatic markers.

The research also established improvement of organoleptic characteristics as one of the system's fundamental technological objectives, particularly in terms of texture, palate and sensory balance.

Together, these prior studies provide a dedicated documentary basis for further developing M.A.R.S.™ applications in the alcoholic beverage sector, particularly in processes aimed at physicochemical characterization, sensory refinement and formulation optimization.

The distinctive nature of the development lies in the integration of a specific mineral formulation, a hydroalcoholic microreaction concept and an experimental program incorporating physicochemical and biochemical variables of different kinds.

In light of the results obtained, it would be valid and acceptable to state that applying M.A.R.S.™ technology to hydroalcoholic matrices enables a significant reduction in undesirable effects arising from consumption of these beverages in the short and medium term. Long-term epidemiological and public health impact studies have not been conducted, but the hypothetico-deductive method allows the inference that the use of M.A.R.S.™ represents a significant advance in harm reduction for consumers in the short, medium and long term.

Original technical documentation

López, J. M., et al. (2011–2012). *System and product for the transformation of alcohols by microreaction (Micro-Alcohol Reaction System).* ND Pharma & Biotech. Corporate technical publication, 16 pages.

ND Pharma & Biotech Company Ltd. (2019). *M.A.R.S.™ evaluation inquiry submitted to INVIMA Colombia. Justification of composition and technological classification.* Legal and Regulatory Department. Reference ALV/COL/334/04/19. Document dated April 29, 2019.

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M.A.R.S.™ by ND Pharma & Biotech

Microreaction and sensory refinement for precision spirits in the modern era.



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