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ON THE ROLE OF MATHEMATICS IN THE MANIPULATION OF BIOMEDICAL PRODUCTS

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ABSTRACT

In the last fifty years, Mathematics has become an important component in the development of Biosciences. Thus, this research was carried out in the form of a hybrid literature review (RLH) on the manipulation of biomedical products (cosmetics and/or medicines), with the objective of explaining the conceptual elements of mathematics related to these processes. We carried out the search between March and October 2024, where we obtained and related 25 works and, when considering the characteristic textual abstracts and relevant information, 08 of these works were selected for analysis. We seek to answer the question: What is the role of mathematics in the production and manipulation of biomedical products? In addition, we consider emphasizing the insurgent relationship between Mathematics and Biosciences based on the results. The data were analyzed from a qualitative-quantitative approach. With the analytical discussion of the results, we conclude that elementary mathematical concepts, such as proportionality, scales and units of measurement are fundamental to the processes of manipulation of biomedical products, such as cosmetics.

Keywords: Manipulation of Biomedical Products. Mathematics and Biosciences. Hybrid Literature Review.

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INTRODUCTION

Since the early 1970s, Mathematics has played an important role in the study of Biosciences. In such a way that studies of mathematical elements, previously applied to Physics, Chemistry or Engineering, have been widely applied to the work of Bioscientists (Batschelet, 1979).

In our research, related to the production and manipulation of biomedical products, we sought to verify how some elementary concepts of Mathematics are used in these dealings.

In the sense of Batschelet (1979, p. 72), the elementary concepts of mathematics are widely used in the relationship between mathematics and the biosciences, either explicitly or implicitly represented in the format of tables and graphs.

Following a line pointed out in Sampaio and Silva (2012, p. 2-3), we recognize that one of the great difficulties for the use of mathematical concepts by bioscientists, in particular, biomedical scientists, biologists and pharmacists, in training, is the lack of an effective relationship between these two fields of Knowledge, at the level of their undergraduate training.

Thus, it is possible, in undergraduate courses, to see biomedical doctors, biologists and pharmacists with little mathematical knowledge and graduates in Mathematics (Bachelor's and Bachelor's degrees), with a minimum idea of what the biomedical sciences are, so that collaboration and interaction between these two areas has become increasingly difficult (Sampaio; Silva, 2012).

However, these areas of scientific knowledge are far from being totally isolated, the biomedical sciences and Mathematics. In fact, there is an increasing number of questions in the world of Biosciences that have been finding answers in the mathematical universe, causing mathematics disciplines to reinvent themselves and combine with other areas (Batschelet, 1979).

In any case, we agree with Sampaio and Silva (2012, p. 3), when they infer that the lack of interaction between Mathematics and Bioscience interferes directly in Basic Education, when, for example, in Biology subjects that require the use of mathematics, for the application of these concepts, there is a lack of preparation for teachers, both of Mathematics and Biology, to explain this connection and its importance, and vice versa.

We affirm that such interdisciplinarity should/can facilitate the learning of contents of both biomedical sciences and mathematics, as it allows an effective application in the resolution of problems that involve the use of appropriate mathematical concepts or even

developed to deal with biomedical problems, even if elementary, and where we seek to relate such mathematical elements to the contents under study.

Our goal is to bring these mathematical concepts for a better discussion and understanding, in relation to mathematical representation in the production and/or manipulation processes of biomedical products, in particular, cosmetics. Initially, from arithmetic, algebraic and/or geometric forms and, later, these allow us an illustrative and/or graphic representation of the processes of production and manipulation of biomedical products.

Thus, we aim to verify the use of (elementary) mathematical concepts in the preparation of biomedical products, to seek an interaction between these two areas of knowledge and, with this, to answer our research question: What is the role of mathematics when handling biomedical products?

We think, according to our framework, of concepts such as Proportionality, Scales (arithmetic), Units of measurement and/or even, implicitly, in the elaboration of Tables and Graphs.

Regarding the production process in the biomedical sciences, we deal with technical, specialized references, such as Rasche (2014), Simões (2013), Silva (2022) and Sokoloski (2023), and also with the mathematical ideas and concepts presented in Batschelet (1979), in addition to Smith (1968) and Murray (2002).

Thus, we infer that bringing the presentation of mathematical elements related to this theme can effectively verify and strengthen such interaction.

One of the justifications for our research, and which we seek with our discussion and results, comes from the confirmation of the importance of the production and manipulation of biomedical products, within the economy of most of the most developed countries, and among which, more recently, Brazil.

METHODOLOGY

This research, of the qualitative and quantitative type, is framed as bibliographic-documentary, which, in the sense of Gil (2008), is a research that uses already prepared material consisting mainly of scientific works, and that allows the researcher an overview of the studies already carried out related to the theme, where documents are used to be explored in a descriptive study – interpretative of this knowledge, that, from an initial treatment, can be re-elaborated according to the objectives of the research, and that should be part of our theoretical framework. In fact, our research follows the line of qualitative and

quantitative studies as recommended by Gil (2008) and in the formats of Gil (2017) and Condurú and Pereira (2007).

We seek to gather research related to our theme, in a specific way, in portals, as a https://google.com to carry out a more complete and relevant study, as in Costa (2023). Thus, in line with what was proposed in De-la-Torre-Ugarte-Guanilo, Takahashi and Bertolozzi (2011), the models of a descriptive/interpretative literature review were considered.

Thus, this research was carried out in the form of a hybrid literature review (RLH) on the manipulation of biomedical products (cosmetics and/or medicines), with the objective of explaining the conceptual elements of mathematics related to these processes.

We carried out the search between March and October 2024, where we obtained and related 25 works and, when considering the characteristic textual abstracts and relevant information, 08 (eight) of these works were selected for analysis.

We aim to answer the question: What is the role of mathematics in the production and manipulation of biomedical products? In addition, we consider emphasizing the insurgent relationship between Mathematics and Biosciences based on the results.

The data were analyzed from a qualitative-quantitative approach. With the analytical discussion of the results, we conclude that elementary mathematical concepts, such as proportionality, scales and units of measurement are fundamental to the processes of manipulation of biomedical products.

In conducting the search, we considered the following inclusion/exclusion criteria: (1) a time frame, which considered the last decade and (2) adequacy to the objective, via keywords: (i) Manipulation of biomedical products and (ii) Mathematics and Biomedical Sciences; with some variants, taking (i) and (ii) as the main filters of the related productions, which will be important elements in our RLH, with a view to greater depth and recognition of the importance of Mathematics in the manipulation of biomedical products (cosmetics).

DISCUSSION AND RESULTS

In our initial search we found 25 works, and after a reading in order to meet our research theme and meet our inclusion criteria, we considered analyzing (08) eight works, referring to the period 2018 – 2023 and, considering more effectively course completion works (capstone course), for their practical and empirical character, which we present in Chart 01, next, and where we consider relating identified elementary mathematical concepts, and their insertion to the theme of biomedical products as pointed out and conceptualized in Galembeck and Csordas (2010).

Chart 01 – Works selected to compose the Review

AUTHOR/ YEAR	TYPE	TITLE	PRODUCT	INSTITUTION
Carvalho (2021)	Capstone Course	**Study on Natural Cosmetic Formulations and Principles**	Natural Cosmetics	Universidade Tecnológica Federal do Paraná
Jurema (2019)	Capstone Course	**Active ingredients of natural origin found in Brazil.**	Body Cream	Universidade Federal da Paraíba
Khodr (2020)	Capstone Course	**Development of a Cosmetic Formulation for a Body Cream containing Pineapple Peel Juice (Ananas Comosus L. Merril)**	Skin Cosmetics	Universidade Federal de São Carlos
Migoto (2018)	Capstone Course	**Skin Cosmetics: Historical and Economic Overview, Raw Materials and Processes, Application Aspects and Applicable Legislation**	Essential Oils	Universidade Tecnológica Federal do Paraná
Silva (2022)	Capstone Course	**Production of Moisturizing Cream with Essential Oil Extracted from Peanut Arachis Hypogaea L**	Moisturizing Cream	Instituto Federal de Goiás
Soares (2020)	Capstone Course	**Production and Development of Moisturizing Cream from Plant Extracts of Cocoa (Theobroma Cacao) and Blackberry (Morus Nigra).**	Organic Cosmetics	Universidade Federal da Paraiba
Sokoloski (2023)	Capstone Course	**Natural and Organic Cosmetics: an Option for Sustainable Innovation.**	Homemade Soap	Instituto Federal do Paraná
Teixeira (2022)	Capstone Course	**Study of a Homemade Soap with Anti-Acne Potential**	Magistral Cosmetics	Universidade Federal de Ouro Preto

Source: Prepared by the authors (2025)

In the text by Carvalho (2021), we observe that this is a study that deals with cosmetic formulations with active ingredients of natural origin on Brazilian soil. A study on natural cosmetics, which seeks to report the raw materials and vehicles, widely used in this segment, as well as their physicochemical analysis and sensory analysis, and with emphasis on some plants used in cosmetic products that are found in Brazil.

For Carvalho (2021), in terms of the treaty by Galembeck and Csordas (2010), the raw materials (active or inactive substances) applied in the formulations, the excipients (vehicles), are the inert ingredients that give consistency to the substances that act when cosmetics are applied. Thus, proportionality criteria are considered to control the quantity (of the material) to be used and its function in the formulation.

In this line, the most treated are: emulsifiers, humectants, emollients, thickeners, dyes, preservatives, fragrances, water, and active ingredients (Carvalho, 2021, p. 20).

As Carvalho (2021, p. 27), deals with natural ingredients, vegetable oils, it is important to consider the stability properties, especially with regard to oxidation, as highlighted in a table that presents the percentage index of oxidation stability in the concentration of the solution (% (p/p)).

When carrying out the extraction process of an Carvalho oil (2021, p. 30), when considering the amount of water needed, specific mathematical formulas are used, such as: $Q = W_i(M_f - M_i)/(100 - M_f) Q, W_i, M_i \; e \; M_f$, where the mass of water to be added (in kg), the initial mass of the sample (in kg), the initial moisture content of the sample (in g/100g) and the final moisture content of the sample (in g/100g) are respectively.

In Jurema (2019), an analysis of the nutritional composition of the juice obtained from the pineapple peel and the biomass obtained is carried out, with a view to developing a body moisturizing cream using the pineapple to generate the active ingredient in the cosmetic formulation. This formulation showed good stability in the physicochemical parameters analyzed. The conclusion is that pineapple peel juice can be consolidated into a sustainable active ingredient to be used in new formulations.

For Jurema (2019, p. 9), cosmetic formulations are complex, initially due to the use of different raw materials in their constitution and, according to the desired use. Pineapple was chosen due to its local production, ease of conservation and the tendency to use natural products in the Brazilian cosmetics market.

For the preparation of the material, some pineapples were purchased and 08 (eight) pineapples were selected, with an average weight of 1.281 kg and an average size (without the crown) of 18.5 cm. During the cleaning process, they were washed with 3 % sodium hypochlorite water, soaked for 10 min, and then sprayed with 70% ethyl alcohol. Then, the pineapple peels were removed, obtaining 2,120 kilograms of mass. The peels were beaten in a blender to obtain the juice. Finally, processes of separation and storage of the extracted juice and biomass were carried out (Jurema, 2019, pp. 15-19).

We observed that for the determination of moisture (% moisture in the sample), by direct heating, in the extracted material, Jurema (2019, p. 20) uses a calculation that relates the wet sample and the dry sample, for a reason, in the form of the quotient $\%Ua = {}^{As}/_{Au}$.

In the work of Khodr (2020), a study of skin cosmetics is treated, which considers: a study of human skin. A study of the main raw materials used in formulations and a study of finances (revenues) in the cosmetics industries, in particular, in Brazil and, considering that,

in 2019 alone, something around 29 billion dollars were moved. As a result, it was possible to analyze the growth prospects of the cosmetics market and the main challenges for the diffusion of moisturizing compounds and the raw materials used in the production processes.

The elements of mathematics are present when: the presentation of a ranking of cosmetics production in the market, in monetary terms, in the billions of dollars, which determines the percentage of market share. Thus, in 2020 Brazil occupies the fourth position in the ranking, with 29 billion, which guarantees 6.1% of the cosmetics market (Khodr, 2020, p. 4).

Regarding the study of human skin, certain issues related to the absorption of substances through the permeability of membranes can be considered, which can be described by formulas such as $PC = \frac{Q}{A} PCQA$, where is the Skin Penetration, is the Permeated Quantity (in mg) and is the permeated area (in cm²); and then by the production of a graph of the PC curve, to determine the permeability coefficient (Khodr, 2020, p. 14).

As for the production of cosmetics described, it is important to consider the percentage concentrations of the acidic components in the products, which Khodr (2020, p.26) presents in a table, according to ANVISA recommendations, which must be followed to avoid possible damage, such as allergies, and which need to consider the age group of people when using them.

Migoto (2018), aimed to develop a moisturizing cream using peanut oils of two different varieties (white peanut and red peanut), and when these oils were then used in the formulation, the moisturizing cream showed good stability, with its homogeneity and viscosity, comparable to moisturizing products for commercial use. In addition, it formed a stable emulsion with good dispersion, both of the dyes and of the added essences.

In his academic work, Migoto (2018) performs some tests, among which we highlight the Concentration, Acidity and Density tests, where he uses devices and instruments, which are necessary or even indispensable in the process.

Regarding the Density test of the oils, Migoto (2018, p. 24) uses a volumetric pipette, a beaker and an analytical balance and, with the masses and volumes noted (obtained in the instruments used), the density is given by the ratio:

$$Density = \frac{sample\ mass}{sample\ volume} \text{ in.} \frac{g}{cm^3}$$

In Silva (2022), who considers the preparation of a Moisturizing Cream, from plant extracts, a protocol is created that considers analyzing the pH, Viscosity, Density, and Color

and Odor Characteristics. As a result, Silva (2022, pp. 26-29) developed a formulation with physicochemical stability, a pleasant fragrance and anti-oxidant properties, using glycolic extracts from cocoa (*Theobroma cacao*) and blackberry (*Morus nigra*).

Related to the application of elementary mathematical concepts, there is the presentation of (02) tables. In the first table, the materials are presented, emphasizing the use of units of measurement to determine the quantity of the components used in the formulation of about 610ml (Silva, 2022, p. 26).

In the second table, it presents the physicochemical analysis to verify the stability of the product at room temperature, where it considers the pH variation, at 5%, and the maintenance of color and odor properties after a period of 90 days (Silva, 2022, p. 27).

The nuances of proportional elements, of percentage, can be inferred when the density decreases, from 0.95 to 0.91g/ml, and the consequent increase in viscosity, from 178.1 to 271.1cPs (centipoise), after 90 days (Silva, 2022, pp. 28-29). Here, we have a "thickening" of the product, which can be a difficulty when it is applied, which suggests greater evaluations of the product's stability.

In Soares' (2020) research, the challenge is about the production and consumption of natural and organic cosmetics in contrast to industrial production, seeking to present the positive aspects related to sustainability and ecological issues. Where she seeks to relate the knowledge of natural and organic cosmetology with the benefits they have to offer to the environment. The results found, in general, were satisfactory, with a possible approximation of an environmental and more ecological characteristic, when considering the problems of production and even the use of industrial cosmetics.

One of his inferences is characterized by the proportional presentation of the components, raw materials that make up natural products, where about 95% must be of organic origin, 5% of organic origin and 50% of the material must be of vegetable origin, compared to industrialized products (Soares, 2020, p. 23).

For Soares (2020, p. 26), a proportional increase in access to cosmetic lines, with natural products, on the market, can mitigate the harmful effects of large-scale industrial production and its toxic waste, which are irresponsibly dumped into nature. In addition, in industrial production water consumption is excessive.

In terms of sustainability, lowering water consumption in production is essential, however, for this it is necessary to make greater use of consevants, which should be used considering their characteristics and aiming at the lowest possible percentage when preparing the final product or even during the development process (Soares, 2020, p. 37).

In this line of natural production, Sokoloski (2023), considering these ecological and sustainability issues, aims in his work to prepare a handmade soap with anti-acne properties and the need to carry out quality control tests. Its basic ingredients are: Ucuúba Butter, Murumuru, Coconut, as well as components Sulfur, Calendula Oleate and Melaleuca.

We have a need for calculation to determine, in practice, the amount of ingredients, for this, it is necessary to use a calculator The soap was prepared through the *hot process* process, heating the dough for an hour and a half. The additives, volatile oils, were only added at the end of the process and then the soap was stored in a plastic film and a cloth. The final product had a good odor characteristic of Ucuúba butter, a good texture, moisture, density and alkalinity (Sokoloski, 2023, p. 23).

In addition to the numerical and percentage calculations of the ingredients used, during the procedures carried out, such as drying, the samples are taken to the oven to check the weight, until we have a constant. Since the Moisture Content is determined using a mathematical equation, namely:$Water\ and\ volatile\ content = \frac{m_0 - m_1}{m_0} \times 100\%,$ where are $m_0\ and\ m_1$ respectively, the mass of the sample in grams and the mass of the sample free of water and volatiles, in grams element (Sokoloski, 2023, p. 26).

In Teixeira (2022), we have the development of three cosmetics, containing Propolis, a bee derivative, a product produced from bees and which has a high complexity in terms of its chemical composition of its components, and in Brazil, the form of green propolis and its extracts is the dominant one, originating from Alecrim-do Campo and, having several applications both in folk medicine and in the elaboration of cosmetics. In this work, the elaboration and presentation of a cosmetic formulation for the products (shampoo, conditioner and soap) was sought. Propolis was selected to compose the formulations, due to its rich chemical composition and which can/should guarantee dermatological, anti-inflammatory, antimicrobial, antiproliferative, and anti-aging actions, among others.

In the formulation, for example, of Propolis Shampoo, Teixeira (2022, p. 18), in addition to the descriptions of the pharmacotechnical functions of the components, shows us a table where the quantities are presented based on units of measurement (mass (g) and volume (ml)) and proportionality relationships (percentage (%)). The descriptions for the formulation of the conditioner and soap, with this principle, are made below, and in an analogous way.

Thus, in our discussion of the results of the analyses of the (08) eight works selected for review, we pay attention to the marked presence of some elementary concepts of mathematics in the processes that involve the production and manipulation of biomedical

products (cosmetics), such as: proportionality in Soares (2020), Carvalho (2021) and Silva (2022), linear relations in Migoto (2018) and Sokoloski (2023), and units of measurement in Jurema (2019) and Teixeira (2022).

In addition to these, we have: the concept of rational division and calculations with currencies, a financial aspect, in Khodr (2020).

These elementary mathematical concepts, among others, of prominence, as we specifically aim, are presented in detail, in Chart 02, below, giving greater clarity and precision to the review work and identifying the relationship between the manipulation of cosmetic products and the mathematics involved in the process.

Chart 02 – Texts analyzed in our hybrid literature review (RLH), with emphasis on the relationship between mathematical products/concepts, in the performance of the processes.

AUTHOR /YEAR	ABSTRACT	PRODUCT	MATHEMATICAL EMPHASIS
Carvalho (2021)	A Study on Some Natural Cosmetic Formulations and Active Ingredients of Natural Origin.	Natural Cosmetics	- Mathematical formulas, decimal numbers. temperature scales and tables.
Jurema (2019)	Development of a Cosmetic Body Cream Formulation containing Pineapple Peel Juice.	Body Cream	- Percentage, scales, charts, and graphs
Khodr (2020)	Cosmetics for Skin: a historical and economic overview, on raw materials and production processes, absorption and legislation.	Skincare Cosmetics	- Mathematical formulas, percentages and presentation tables, of the double-entry type.
Migoto (2018)	Production of a Moisturizing Cream from *Arachis Hypogaea L Peanut Essential Oil*	Essential Oils	- Proportionality (parts) in the presentation of the components.
Silva (2022)	Production, manipulation and development of a Moisturizing Cream from Cocoa and Blackberry Plant Extracts.	Moisturizer	- Percentage, units of measurement, and tables.
Soares (2020)	A study on Natural and Organic Cosmetics: a sustainable innovation option.	Organic Cosmetics	- Proportional formulas, percentage, graphs and tables
Sokoloski (2023)	Study of a Homemade Soap with Anti-Acne Potential	Homemade Soap	- Proportionality, scales and units of measurement
Teixeira (2022)	Development of Magistral Cosmetic Formulations that contain Propolis and/or bee derivatives.	Masterful Cosmetics	- Mathematical formulas, proportionality, tables and graphs

Source: Prepared by the authors (2025)

The (08) eight course completion works (capstone course), which we selected, have an explicit practical-experimental aspect. In addition, with regard to biomedical products, they deal with the production and manipulation of cosmetics and were all written in Portuguese.

We carried out an analytical-descriptive study of the works, considering Bardin (2016) and, anchored in a description of the contents of the texts, we aimed at an interpretative discussion of the results.

In fact, among the works selected in this RLH, only in Carvalho (2021) and Khodr (2020), we have more general presentations, including historical aspects of the theme of cosmetics.

Thus, in most of the works (six) a mathematical representation was developed and a necessary presentation and use of elementary mathematical concepts, such as the concepts of linear relations, proportionality, formulas, numerical tables and units of measurement, as advocated by Batschelet (1979), Smith (1968) and Murray (2002), which demonstrates the importance of the role of mathematics, from the knowledge and application of concepts, at first, elementary, in the production and manipulation of cosmetics, whether on an artisanal or industrial scale.

FINAL CONSIDERATIONS

In this research, as a result of an analytical study of (08) eight undergraduate course completion papers, selected, with emphasis on the relationship between the production and manipulation of cosmetics and mathematics, we seek to identify and evidence the use of elementary concepts of mathematics, which are essential in the realization of these processes of production and manipulation.

Thus, we have achieved a positive answer to our research question - What is the role of mathematics in the production and manipulation of biomedical products? from our discussion and the results obtained.

We found that the application of elementary concepts of mathematics, such as linear relations, units of measurement, formulas and, in particular, proportionality relations, more specifically, the concept of percentage, are a constant and a necessity for the realization of research, in the analyzed works.

From this, it is pertinent to infer the importance of these elementary concepts of mathematics when producing and/or handling cosmetic products. This finding allowed us to point out, as an offshoot of our RLH, the need to include a discipline of mathematics elements in undergraduate courses in Biosciences, such as: Biomedicine, Biology and Pharmacy

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