

AHP APPROACH TO DEVELOPING A NEW NATURAL TOOTHPASTE PRODUCT

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Abstract:

Background: A new approach to marketing an inventive product is needed as the development of a new natural toothpaste product is challenging. When choosing herbal-based products, consumers value taste and flavor, preferring natural, appealing flavors over synthetic flavors. Health advantages are also noteworthy, especially, herbal smells promote well-being and satisfaction.

Purpose: The study main objective aimed to examine how the Analytic Hierarchy Process (AHP) was used to create a new natural toothpaste product. The study also aimed to design a strategy for innovative toothpaste commercialization based on nanohydroxyapatite (nanoHAP) and Curcuma aeruginosa.

Design/methodology/approach: The AHP technique used to evaluate and prioritize elements of natural ingredient, and consumer preferences. The study framework identified herbal toothpaste benefits with known oral health benefits, such as antibacterial, anti-inflammatory, and desensitizing qualities, as well as consumer preferences for tooth paste. These attributes were ranked according to their performance using the AHP framework.

Findings/Result: The results of the study stated that the new natural toothpaste, based on nanoHAP and Curcuma aeruginosa, was designed based on quality natural ingredients and consumer preference for naturalness, influencing formula design and marketing efforts. The strategy to develop new toothpaste aimed to provide a holistic health solution, emphasizing natural components and general health perspectives. This strategy could capture the attention of the target market and outpace competitors, attracting customers interested in natural health products.

Conclusion: This study addresses the possibility of using nanoHAP alongside Curcuma aeruginosa in a natural toothpaste product that can enhance the remineralization and antibacterial characteristics of the dental product. The research suggests incorporating nanoHAP with Curcuma aeruginosa in a natural toothpaste product for holistic health solutions. Strategies include targeted marketing, loyalty programs, and strategic partnerships, ensuring a comprehensive and data-driven approach to reach and engage target audiences.

Originality/value (State of the art): The AHP facilitates complete review, data-driven planning, and commercial viability for commercialization strategy. AHP aids in balancing functional benefits with quantifying subjective assessments, and incorporating customer feedback to increase product success in the competitive oral care industry.

Keywords: nanohydroxyapatite (nanoHAP), curcuma aeruginosa, consumer preferences, functional benefits, commercialization strategy

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INTRODUCTION

Product differentiation is important in the strategic management of businesses so much so that the creation of new and unique products remains a significant business strategy. Companies that possess capabilities that can enable them to bring new products into the market to meet the needs of the consumers competitively over time are well-placed to attain a strong competitive position within their operating markets (Conner, 2020). This is especially so in the areas of personal care and cosmetics where customer is always on the lookout for newer and better solutions to his/her health problems. One of the subdivisions of the personal care industry that has been emerging as a niche direction is the line of natural toothpaste equipped with the innovations of the advanced materials and additives for the oral health care. The global personal care and cosmetics industry is rapidly changing with the rising global popularity, achieving the highest priority to the production of effective and eco-friendly products. Some customer demands transcendent from mere utilitarian and self-actualization requirements towards the possession of sustainable products and services (Kumar et al. 2006; Septiani et al. 2022).

Dental plaque formation on teeth surfaces is unwelcome both for esthetic and for pathogenic considerations, as it develops into dental cavities, gingivitis, periodontal diseases and poor breath (Tatikonda et al. 2014.). Dental brushes floss, mouth rinses and dentifrices are employed in the control of the plaque the population—however only about a third can properly use these mechanical aids. The grinding pastes have included chemical preventive agents including triclosan and chlorhexidine that are responsible for changing the discolouration of the teeth and flavors. Over the past few years, consumers have turned toward the use of natural and efficient oral care products. Ingredients originally used for herbal dentifrices are chamomile, echinacea, sage, rhatany, myrrh, and peppermint oil. There is the application of smart biomaterials together with plant derivatives in toothpaste products as another area of advancement. Therefore, nano-hydroxyapatite (nanoHAP) and *Curcuma aeruginosa* have been identified as the valuable ingredients because of the remineralizing and the therapeutic effects respectively. In this changing environment, nanohydroxyapatite (nanoHAP) has become incorporated because of the ability of the material to remineralize dental enamel similar to the enamel present on human teeth making

natural toothpastes more effective. At the same time, *Curcuma aeruginosa* – a plant, which is effective in the fight against inflammation and bacteria, has additional positive effects which can positively influence the oral health of people and corresponds to the trends of the modern naturality. Therefore, the integration of these two components meets the needs of oral care effectively and makes new products in the competitive environment more available and accepted among different populations. However, the development of a toothpaste where these two elements would be incorporated entails a systematic approach to maintain the correct balance of innovation / commercialization goals and to align innovations in a new product with consumer expectations.

The studies indicate that the nanoHAP can adhere to the surface of the teeth, while its hard particles get embedded into the enamel microrepairing any defects that may be present and hence reduces the chances of decay (Sari et al. 2022). A review of the research carried out on nanoHAP containing toothpaste and fluoride containing toothpaste indicates that nanoHAP can significantly decrease the rate of tooth enamel demineralization, reverse early stage caries and enhance oral health without the risks of toxicity from ingesting fluoride (Anil et al. 2022). *Curcuma aeruginosa* is Zingiberacea family plant which is relative to the turmeric but the plant contain different bio-active compound. It has constituents like essential oils and curcuminoids and it is known to possess high antimicrobial, antifungal and antid inflammation properties. These properties make it a perfect natural substitute for synthetic chemicals when it comes to the prevention of gum diseases as well as the reduction of plaque formation in our mouth and the regulation of the flow of oral microbiome (Sari et al. 2022). Adding *Curcuma aeruginosa* in the toothpaste gives a natural method of limiting *Streptococcus mutans*, which is the key bacterium that direct tooth decay. In the same regard, it eases inflammation known in gum form as Gingivitis this is an ordinary disease which has symptoms such as swollen and bleeding gums. This makes it especially good in creating toothpaste for those with gum issues or for those who prefer a natural oral health regime.

This study shows that the process of new product development involves a combination of various factors that has to be taken into account. As soon as organizations finish the product development stage, they need to develop an adequate commercialization

plan for the product to do well in the market. This includes; positioning strategies of products, the appropriate pricing model, the customers, and the ever-shifting market forces. The most valuable aid in this regard is the Analytic Hierarchy Process (AHP), which is an effective instrument for ordering and comparing multiple criteria, and definite alternatives as well. The AHP is specifically useful for new product commercialization as the business gets to combine both the qualitative and quantitative aspects of decision making hence improving the outcomes (Battistoni et al. 2013). Through AHP, companies are able to give rational rankings to various options in marketing strategies, distribution channels and pricing mechanisms through the identification of the most suitable strategy to follow (Gerdsri and Kocaoglu, 2007).

It is, therefore, appropriate to develop a commercialization strategy for toothpaste based on nano-hydroxyapatite (nanoHAP) and Curcuma aeruginosa using AHP because it enhances the consideration of internal and external factors that impact on product commercial success. The process of taking a new product to the market entails consideration of the customer taste, competitors, product price and product promotion. All of these elements involve some sort of trade-off; using the AHP method allows for the management of these trade-offs in order to achieve the best result. For example, the necessary positioning of a new product on the market is that AHP helps to compare choice variants on this criterion, for example, the positioning strategies can be a premium, mid-range, or budget price. Such criteria might include cost of production, the target market, and the rivals in the market. The logical structure of the pairwise comparison technique used in AHP enables identification of which positioning strategy has the highest chance of achieving the market success in light of the producer's capabilities and the market environment. This study seeks to highlight the importance of AHP as an analytical tool in designing an effective commercialization strategy for new products as well as its aid in managing the conflicting priorities that contribute to the success of a new product.

METHODS

This study employed a descriptive research design making it a case study. The study was undertaken between June 2023 and December 2023 at School of Business, Department of Physics, Faculty of

Mathematics and Natural Sciences, and Tropical Biopharmaca Research Center, IPB University, Indonesia. Both primary and secondary forms of data sets and sources were employed in this study. Secondary data obtained from literatures, while primary data obtained from interview. Experts were the people from whom primary data was collected using questionnaires as data collection instruments. Interfacing's expert sources for the information needed based on the area of the expertise was a qualitative method that applies to a given topic to obtain the information required was interviewing (Meuser and Nagel, 2009). Since the assessment of the research's variables required information from experts. The participants interviewed during this study were five individuals.

AHP is one of the most commonly used methods considered for solving complex, non-programmed and multi-criteria decision-making problems (Saaty, 2008). The researches that have been conducted with the formulation of AHP documented have been conducted in many fields, and it was found that the strength of AHP lies in the ability of the formulation to mimic the management and/or the experts' opinion of where the importance resides which would be attributed to different influential factors as well as to organize a multi-attributes system matrix. The AHP is a decision model that is composed of three basic processes namely; the construction of a hierarchy, the prioritization process, and the result computation.

The integration of AHP in formulation development of a new toothpaste product allows for modulation in order to consider the preference of customers and its effectiveness. AHP first forms a tree like structure from a multi attribute decision making problem. The structure of the decision problem is created by the breakdown according to its principal constituents. The study designed the AHP framework that follows the project goal.

The first one is the grand or master goal also known as the objective at the apex of the hierarchy. In this study, the goal was to develop a new natural toothpaste product. The decision-influencing factors are known as attributes or criteria and form part of the subsequent levels each of which may have many parts. Features do not overlap and the significance of the features does not depend on the elements that occupy lower positions in the hierarchy. The criteria selection involved the following; The literature review aimed at establishing

the existing shortcomings with the conventional toothpaste products and finding out the basics about nanoHAP and Curcuma aeruginosa as oral health promoting agents. After that, the hierarchy of criteria was built with division of such significant measures as quality of natural ingredients (A Kanouté et al. 2022), consumer preference for naturalness (Simão, 2021), consumer purchase behaviour, and consumer preference for brand (Acharya et al. 2018). Sub criteria for quality of natural ingredients were source and production process (Lippert, 2013), and purity and effectiveness (Vranic et al. 2004). Sub criteria for consumer preference for naturalness were usage experience (Dani, 2013), and social and environmental influence (Malea et al. 2020). Sub criteria for consumer purchase behaviour were price sensitivity (Umoh et al. 2013), perceived value (Sinha and Verma, 2020), and budget constraints (2023). Whereas, sub criteria for consumer brand preference were offered value (Gupta, et al. 2020), brand consistency (Johan Lanseng, and Erling Olsen., 2012), customer experience (Adjei,et al. 2014), influencers and testimonials (Rasyid, 2022), and packaging design (Adjei,et al. 2014). The objectives were design based on the needs: to determine when a new product needs to be developed and when it is about to be launched in the market, to determine the right proportion of innovation and commercialization to follow, to determine where the quality of natural ingredients meets the cost of using them, or establishing associations for a new product to fit the consumers' tastes. The market competition: to create differentiation in the market. Lastly, the hierarchy completed by the alternatives strategy for commercialization such as position the product as a holistic health solution, targeted marketing, attractive loyalty, and strategic partnership program.

The prioritization process took place after that, as to coordinate the system needed to determine the importance of items at each level based on the initially created hierarchy. From the second level and terminated at the last level is the pairwise judgment. There are comparisons made pairwise between elements in one level based on the extent of their impacts on the positioning of an element in the immediately higher level (Saaty, 2008). Applying pairwise comparisons to typical qualitative evaluations guarantees that the prioritization of formulation components is objective. When the most preferred attributes were arrived at, commercialization strategy were made and subjected to alternative strategies against develop a new natural

toothpaste product. Not only does this cyclic produce involved stakeholders through surveys and feedback mechanisms, but it also guaranteed the product fits the science and technology changes and the customer demand by proving its feasibility in the Oral Care Market.

A nine-point measurement scale is outlined. On one of the forms, the person making the decision has to make a choice and circle which element in each of the pairs they like more. The multiple relative weightings of decision attributes compared to each other are equal importance (1), slightly more important (3), moderately more important (5), very strongly more important (7), and extremely more important (9).

In pair-wise comparison, ratio scale is used in order to determine the relative importance and weight about the factors/criteria or between the alternatives. This type of ranking lets the decision maker use his/her experience and knowledge in a direct and natural way (Saaty, 2008). Once the preference matrices have been established, there begins the arithmetical part in order to normalise and arrive at priority weights for each of the matrices. The AHP process then decides on the level of consistency of the pair-wise comparisons that is, the consistency ratio (CR) of all matrices. According to Saaty (1994, 2008), in order to pick a adequate indicator for the AHP study, the CR value must be less than 0.10.

RESULTS

According to the AHP model (Figure 1), criteria were the comprehensible and needful factors that had been employed to analyze and to rank different options regarding a definite goal. The criteria in this AHP model offer a structure on how the multi-criteria decision-making of the essential aspects in establishing a new natural toothpaste can be made efficiently. When decision-makers have to decide between the quality of natural ingredients, how much the consumer actually cares about naturalness, how much the consumer is willing to buy and relating that back to brand preference, it can help guide the decisions that are made. The criteria and sub-criteria's local or normalized priority (i.e., relative to the parent elements) and global priorities (i.e., related to the goal) were calculated. Next, the consistency ratios for different decision matrices were calculated. The criteria and sub-criteria were assigned

weight according to first level and second level of importance, which was useful to give better importance to some of it. The AHP results for the criteria to develop a natural toothpaste product, are as follows:

The Quality of Natural Ingredients was found as the main important criterion in designing the new natural toothpaste based on nanoHAP and Curcuma aeruginosa as oral health promoting agents. The second important criterion was Consumer preference for naturalness. Both criteria affected the decision in designing the formula, while the other criteria were used in the effort to market the product after the formula decided.

1. Quality of Natural Ingredients (0.40)

This criterion helped to determine the quality of natural ingredients incorporated in the production of the toothpaste product based on nanoHAP and Curcuma aeruginosa as oral health promoting agents. The quality of natural ingredients is crucial as it affects the product's effectiveness and safety. This criterion is divided into two sub-criteria: Source and Production (0.625), assessed where the natural ingredients come from and how the different products are manufactured. Reliable sources and good production processes ensure high-quality ingredients. Purity and Effectiveness

(0.375), which examined the extent to which the natural ingredients meet the intended for delivery, for example, cleaning teeth, fighting cavities, and supporting oral health. Therefore, Source and Production was found more important in this criterion.

2. Consumer Preference for Naturalness (0.30)

This criterion assessed the level of consumers' appreciation and implementation of natural components in products. Consumer demand for natural items prevails because it determines consumer behavior to a considerable extent. This criterion includes: Usage Experience (0.50), captures the usage of the natural ingredients and how the natural ingredients that are used in the product. Generally, customers prefer to use a product that provides interaction with natural body feeling and product that is useful in some ways. Social and Environmental Influence (0.50), assesses the consumers' attitude toward buying products with natural ingredients in the light of social and environment-related factors. In general, consumers may have a preference of the toothpaste products which are ecologically safe or endorsed by their people. Therefore, both criteria were found equally important in this criterion for nanoHAP and Curcuma aeruginosa as oral health promoting agents.

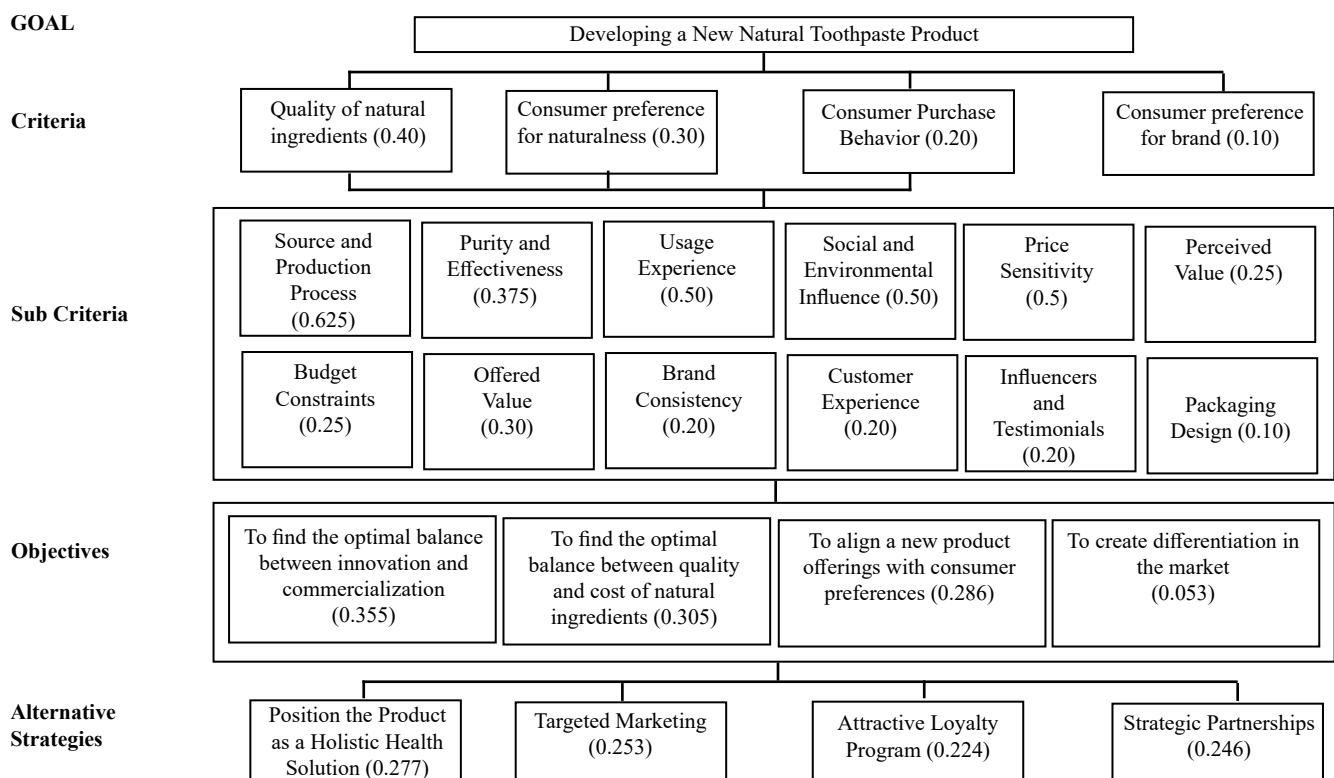


Figure 1. AHP structure in Developing a New Natural Toothpaste Product based on nanoHAP and Curcuma aeruginosa

3. Consumer Purchase Behavior (0.20)

This criterion evaluated the influences of consumer buying behaviour for a new toothpaste with natural ingredients. It is, therefore, important for marketers to study the consumer purchase behavior if they want their marketing strategies to work. This criterion consists of three sub-criteria:

- a. Price Sensitivity (0.5), explained the changes in consumers' buying behaviour in response to price changes that occurred over the previous period. When products are manufactured at a very high price, people cannot afford them and when products are manufactured at very low prices, people think that it is low quality.
- b. Perceived Value (0.25), rated directly the perceived value of the product through brands. Consumers also depict products with different brands to be of added value and hence agrees with the position held by Apple.
- c. Budget Constraints (0.25) defined the amount of money available for a specific project or decision, shows the measure of the importance given to this constraint within the decision-making process.

Therefore, price sensitive was found more important in this criterion.

4. Consumer Preference for Brand (0.10)

Criterion Consumer Preference for Brand assessed the extent to which consumers have a preference for a specific brand while making a purchasing decision. This criterion proved important because building a strong brand is a powerful factor that affects consumer trust and customer loyalty. The weight of 0.1 signified that the particular factor was highly influential towards the final decision-making process. This criterion was further divided into five sub-criteria:

- a. Offered Value (0.30), this sub-criterion checked on the brand value that consumers perceived the brand to deliver. It includes aspect like quality, the value it offers, and the product worth as compared to other similar products in the market. This means that by perceiving a higher value in the product any consumer who uses that product is bound to be satisfied and hence becomes loyal to the product.
- b. Brand Consistency (0.20) it related to the extent the brand functions as a square peg in a square hole, fulfilled its promises and is coherent throughout

all its encounters. This concerns such things as the message and the design all being harmonious. Brand equity is due to repeat patronage arising out of consumers' consistent association between the two entities.

- c. Customer Experience (0.20); it focused on the sum total impression that consumers have about the brand. It constitutes areas like customers' responsiveness, convenience in procurement, and latter accompaniment. A positive customer experience improves satisfaction and becomes a key to increased customer frequency.
- d. Thus, the sub-criterion Influencers and Testimonials (0.20) was of great importance for the formation of consumers' attitudes towards a particular brand. This sub-criterion looks at the effect of recommendation by other social media influencers and generally, other customers' recommendations. The advantages of influencers include: the audience can be wide and followers can become credible, while testifiers can be convincing.
- e. Packaging Design (0.10), in this regard, it focused on the packaging design and appearance and usability of the packaging. Packaging in modern environments can make product attractive and easily recognizable, which make the product more appealing and easier to use. This is an important factor despite having a weight of 0.01; packaging design has a role in brand image and consumer choice.

Therefore, offered value was found more important in this criterion. In the next hierarchy, we analyzed the objectives according to the AHP model for the creation of a new natural toothpaste product based on nanoHAP and Curcuma aeruginosa as oral health promoting agents. The objectives are therefore very important as they shape the right direction to be taken in order to achieve the intended goal. The following objectives set out clear direction when it came to the creation of a new natural toothpaste product. This means that by identifying strategic directions that actually address issues such as the balance between innovation and commercialization or quality and cost, consumer preferences and the creation of a market niche, the project can make better decisions that will ultimately improve the product's prospects. The decision-making process was both strategic and comprehensive in making because each objective was weighted depending on the degree of its importance. In

the objective, To Find the Optimal Balance Between Innovation and Commercialization was found more important than the others. Here are the detailed findings for each objective:

1. To Find the Optimal Balance Between Innovation and Commercialization (0.355)

This objective was meant to allow the creation of new features to the new toothpaste product without compromising on the cost of production. Whereas Growth accomplishes this by implementing innovation as a strategy of establishing the product market niche; on the other hand, Marketing incorporates commercialization as a strategy of making the product available and desirable by the consumer. As for the fifth and sixth objectives the weight of 0.355 implied the significance of this goal for further development, as it stressed the fact that Navistar should innovate constantly while keeping the product both marketable and profitable.

2. To Find the Optimal Balance Between Quality and Cost of Natural Ingredients (0.305)

This objective aimed at maintaining a fine tune between the quality of natural ingredients applied in the toothpaste and their price. Effective ingredients are needed for the effective functioning of the product and to meet the consumer needs; however, they are expensive. The weight of 0.305 was used to indicate that this was a very core parameter vital to be maintained if the product has to be both efficient and cheap. It is crucial for the delivery corporate strategy in selling products and services in order to retain competition while ensuring profitability.

3. To Align New Product Offerings with Consumer Preferences (0.286)

This objective centered on identifying that the recently developed toothpaste product meets the customer needs and demands. The needs of the consumer are dominant factors that need to be understood and addressed to achieve high results with the product. The weight of 0.286 supported the signification of the consumer orientation when creating new products. By making the product to fit in the needs and wants of the consumers, the company is able to increase the consumers' satisfaction, their loyalty as well as their overall market share in the market.

4. To Create Differentiation in the Market (0.053)

This objective was to establish a new and separate place in the market for the newly developed toothpaste product. Differentiation is the creation of the product attributes or benefits that must be unique from the various products within the same category. The weight of 0.053 implied that as far as differentiation is concerned, it has been considered to be far less of a strategic priority management priority compared to innovation, quality, cost and consumer alignment. But it can be very useful for the customer's attraction and dedication because it means that an organization provides something that other similar organizations do not.

According to the criterion and the objectives stated above, toward the attainment of the aforesaid goal, several alternatives' strategies in the AHP framework of formulating a new natural toothpaste product based on nanoHAP and Curcuma aeruginosa as oral health promoting agents. The success and relevance of each of the named strategies were evaluated. The strategy to Position the Product as a Holistic Health Solution was found more attractive compared to other alternative strategies. Below are the detailed descriptions of each alternative strategy:

1. Position the Product as a Holistic Health Solution (0.277) This strategy was to ensure that the new toothpaste provided a healthy solution to human health. On this subject the emphasis is put on the natural components and the general health perspectives, not only the functions of the teeth and gums. In this manner, the brand can sell the toothpaste with intentions of maintaining general health and this aspect can attract customer interested in natural health products. Thus, the rather high value of 0.277 revealed in the assessment of the ability to capture the attention of the target market and outpace competitors showed the high potential of this strategy.
2. Targeted Marketing (0.253) This referred to the creation of unique marketing promotions for unique market segment. This application involves the collection of data and information on the buying behaviours, interests and age, sex and income levels among the targeted segments to tailor messages that will be convincing to the receivers. Marketing intelligence is effective in organizing the target markets where resources can be invested so as to

maximize on marketing since it directs the focus of marketing. Such score as 0.253 pointed out on highly sensitive of this strategy by consumer to increase the operation's sales figures.

3. Attractive Loyalty program (0.224) A well-designed loyalty program aimed at encouraging consummation of goods by the same customer whenever they are in the market. This strategy may entail such things as giving some high-quality products or products which are cheap in some specific shops to faithful shoppers. In this case, the brand can be able to build a customer base of loyal clients thus increasing product circulation within the firm. The findings revealed that the average score was 0.224, which showed that as much as this strategy is important it is slightly less important than positioning and targeted marketing.
4. Strategic Partnerships (0.246) Strategic partnerships were to work with other brands, companies or celebrities to improve on the market image and reputation of the product. Such efforts can be a form of co-branding where companies collaborate on marketing or joint health and wellness themed marketing collaborations with endorsers. The brand then gets a chance to harness the appeal and following of the partner thus increasing its chances of exposure within the market place. The result of the analysis equals 0.246 that means the usage of this strategy has a rather high possibility to contribute to building the market niche and attract new customers to consume this product.

Managerial Implication

In the innovation aspect of natural toothpaste, the cases of the accustomization of AHP suggest other aspects of the system that may have intricate influences in the innovation system. Through the use of prioritized criteria like quality of natural ingredients, consumer preference for naturalness, consumer purchase behaviour, and consumer preference for brand, stakeholders can in a step-by-step manner assess the possibilities of different formulations including those that involve nanoHAP and Curcuma aeruginosa. The AHP model reveals the pros and cons of every decision, so researchers and formulators are capable of dealing with the optimal choice of ingredients and general design of the new toothpaste product. High-end consumer trends that seek natural and sustainable oral care solutions are likely to grow, and the AHP-driven

framework improves the innovation pipeline while also marketing new ideas for products that will suit the changing market. Therefore, future natural toothpaste innovations based on the given methodology will likely result in possibilities of delivering scientifically sound toothpaste providing corresponding values that have the ability to reshape the market and loyalty.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The conclusion of this research continues to emphasize the promising benefits for incorporating the nanoHAP with Curcuma aeruginosa when designing a novel natural toothpaste product. Conclusion These alternative strategies offer a comprehensive approach to achieving the objectives of developing a new natural toothpaste product. By positioning the product as a holistic health solution, implementing targeted marketing, offering an attractive loyalty program, and forming strategic partnerships, the brand can effectively reach and engage its target audience. Each strategy is evaluated based on its potential impact, ensuring that the decision-making process is both strategic and data-driven.

Recommendations

Moreover, the comprehensive analysis described herein provides directions for future research to uncover related possibilities, especially in asserting that more elaborate clinical trials should be conducted to evaluate the effectiveness and safety of the product. Finally, this study opens up other lines of research in proposing how a new action can be created in the dental care category as identified above; this also means that there is need for more advancement in the dental care category to cover for the new natural consumer shift in the health products category while at the same time balancing how sustainable oral health can be attained in the future.

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