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The works must be unpublished and refer to topics of Experimental design, commerce, options, rural-flora and fauna, agronomy, natural and other topics related to Biology and Chemistry.

Presentation of the Content

As a first chapter we present, *Natural treasure of Acapulco: preserving the magic of Roqueta Island*, by NIÑO-GUTIÉRREZ, Naú Silverio, NIÑO-CASTILLO, Jacob Elías and NIÑO-CASTILLO, Isaías Naú, with adscription in Universidad Autónoma de Guerrero, as a second article we present, *Postpartum reproductive efficiency of hair breed sheep additioning bypass fat and a gluconeogenic ingredient*, by OSORIO-MARÍN, Yolanda, CONDE-HINOJOSA, Miguel Paul, GALLEGOS-SÁNCHEZ, Jaime and TORRES-HERNÁNDEZ, Glafiro, with adscription in Benemérita Universidad Politécnica de Francisco I. Madero, Universidad Autónoma Chapingo, Colegio de Postgraduados, as the third chapter we present, *Seasonal variation in the concentration of phenolic compounds in bee honey*, by DE LA CRUZ-MARTÍNEZ, Wendy Madahí, ARRIETA-GONZÁLEZ, Armando, SILVA-MARTINEZ, Karla Lissette and GUERRA-RAMIREZ, Diana, with affiliation at Tecnológico Nacional de México- Instituto Tecnológico Superior de Tantoyuca, as fourth article we present, *Design and construction of a model rocket using computer-aid simulation for L1 Tripoli Certification*, by GOMEZ-ROA, Antonio, CONTRERAS-MORALES, Oscar Adrián, HERNÁNDEZ-TORRES, Martha and ORTEGA-ALVAREZ, Eduardo, with adscription in the Universidad Autónoma de Baja California, Instituto Politécnico Nacional.

Content

Natural treasure of Acapulco: preserving the magic of Roqueta Island

Tesoro natural de Acapulco: preservando la magia de la Isla Roqueta

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Abstract

In the context of the climate crisis, community resilience is vital in addressing environmental challenges. This study examines climate change resilience on Roqueta Island, Acapulco, Mexico. The objective was to assess Roqueta Island's resilience strategies in the face of climate threats, hypothesizing that these measures encounter challenges due to climate threats and tourism. Justification: Acapulco bay faces tropical storms, and Roqueta Island is crucial; understanding how resilience and tourism impact sustainability is essential. Methodology: We conducted comprehensive documentary research on climate change, resilience, and island tourism. Six field trips with participant observation took place from January to July 2023. Results: Acapulco bay faces constant climate threats. Roqueta Island, vital to Acapulco, is impacted by intensive tourism. Local conservation efforts, sometimes with tourist concessionaires, aid preservation but face challenges. Conclusions: Extreme weather increasingly affects the Mexican tropics. Despite resilience measures, they're deemed insufficient to address climate change and tourism. Robust strategies are urgently needed to safeguard Roqueta Island's environment.

Environmental, Resilience, Sustainability

Resumen

En el contexto de la crisis climática, la resiliencia comunitaria es fundamental para abordar los desafíos medioambientales. Este estudio examina la resiliencia al cambio climático en la Isla Roqueta, Acapulco, México. El objetivo fue evaluar las estrategias de resiliencia de la Isla Roqueta frente a las amenazas climáticas, con la hipótesis de que estas medidas enfrentan desafíos debido a las amenazas climáticas y al turismo. Justificación: La bahía de Acapulco sufre tormentas tropicales, y en la Isla Roqueta es crucial; comprender cómo la resiliencia y el turismo afectan la sostenibilidad local. Metodología: Realizamos una investigación documental exhaustiva sobre cambio climático, resiliencia y turismo en la isla. Se llevaron a cabo seis viajes de campo con observación participante de enero a julio de 2023. Resultados: La bahía de Acapulco enfrenta constantes amenazas climáticas. La Isla Roqueta, vital para Acapulco, se ve afectada por un turismo intensivo. Los esfuerzos locales de conservación, a veces en colaboración con concesionarios turísticos, ayudan a preservar el entorno, pero enfrentan desafíos. Conclusiones: El clima extremo afecta cada vez más los trópicos mexicanos. A pesar de las medidas de resiliencia, se considera que son insuficientes para abordar el cambio climático y el turismo. Se necesitan con urgencia estrategias sólidas para proteger el entorno de la Isla Roqueta.

Ambiental, Resiliencia, Sustentabilidad

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Introduction

The tourism industry is a fundamental pillar of the Mexican economy, and Acapulco Bay has long been an iconic destination in the country. However, in an increasingly climate-challenged and environmentally degraded world, sustainable tourism has become an urgent necessity (Carvajal-Oses et al., 2023). At the state level, the central issue of environmental education in Guerrero is related to a lack of socio-territorial reflection in the face of environmental deterioration under conditions of climate change. Therefore, the indirect causes are: *a)* minimal environmental training and education; *b)* weak public policy on environmental education; *c)* disjointed environmental dissemination, outreach, and communication; *d)* a lack of systematization of assessment tools for environmental education processes, and *e)* limited research cases in environmental education in the context of climate change that can provide a clear understanding of the current situation (Niño-Castillo & Niño-Gutiérrez, 2023).

At the local level, the research problem is as follows: How can an effective environmental education program be designed and implemented on Roqueta Island to comprehensively address the challenges of climate change, including resistance, recovery, and adaptation actions, in order to promote environmental resilience and sustainability in this island community?

The problem lies in the absence of an on-site environmental education program, causing local stakeholders to undertake various actions with limited planning (Niño-Gutiérrez et. al., 2021). This, in turn, results in landscape alterations in the nearly flat portion of the island, 0-20 meters above sea level, which is the area influenced by the land-sea interface where activities such as "free diving (snorkeling) and scuba diving (with oxygen tanks)" take place (Niño, 2014).

Research question: How can an effective environmental education program be designed for Roqueta Island that incorporates climate change resilience, recovery, and adaptation actions to promote environmental resilience and sustainability within the community?

To address this question: The main objective is to synthesize effective climate change resilience, recovery, and adaptation actions on Roqueta Island in Acapulco, Guerrero, Mexico.

In this regard, designing and implementing a comprehensive environmental education program that addresses the challenges of climate change on Roqueta Island is justified for several fundamental reasons:

A. Vulnerability to climate change; on Roqueta Island, this includes rising sea levels, extreme weather events, and ocean acidification. These changes pose a significant threat to the community and its natural environment.

B. Need for awareness and action: The business community on Roqueta Island needs to comprehend the effects of climate change and be prepared to take concrete measures to mitigate and adapt to these impacts. Environmental education is a key tool to increase awareness and capacity for action.

C. Conservation and sustainability: The island boasts unique and valuable marine and terrestrial ecosystems. The conservation of these ecosystems and the promotion of sustainable practices are essential to preserve biodiversity and long-term well-being for all (Niño-Gutiérrez, 2022a).

D. Local empowerment: A well-designed environmental education program will not only inform tourists but also empower residents to actively engage in climate change mitigation and adaptation, thereby strengthening Roqueta Island's resilience.

E. Contribution to science and practice: The implementation of this program can serve as a valuable case study for other island communities facing similar challenges. The knowledge and experiences gained on Roqueta Island can contribute to the development of effective strategies in other parts of the world.

Methodology

Desk work was conducted, encompassing the search, reading, and analysis of printed and digital documents regarding Roqueta Island, as well as exhaustive analysis of printed and digital documents related to the topics of climate change, resilience, and island tourism. During this phase, the identification of the island landscape was carried out within the period of January-February 2023. This desk work was complemented by field research consisting of six visits between January and July 2023, during which information was collected through participant observation.

Through counts conducted during the island visits, a total of 900 individuals were tallied who visit this site during the day, categorized as follows: domestic tourists 60%, residents 30%, vulnerable groups 5%, and international tourists 5%. These data were recorded in the field logbook, and photographic documentation was taken to illustrate the maritime-terrestrial conditions. Additionally, through participant observation, the use of island tourism was observed. Finally, the manuscript was drafted.

Framework: Historical, legal, and theoretical-methodological, the international precedents are related to the following: Agenda 2030 for Sustainable Development (September 2015); Incheon Declaration 2015 (May 2015); Convention on Biological Diversity (September 1988); Vienna Convention for the Protection of the Ozone Layer (September 1988); Paris Agreement (November 2016); Decade of Sustainable Consumption and Production Program Framework (2015); and the Sendai Framework for Disaster Risk Reduction 2015-2023 (March 2015) (Naciones Unidas, 2015).

Regarding environmental education programs worldwide, notable examples include: *i)* Environmental education program in Pacific Islands, where several pacific countries, such as the Maldives and Fiji, have implemented environmental education programs focused on climate change adaptation and sustainable natural resource management; *ii)* Caribbean Islands conservation project, which has conducted conservation projects on islands to protect marine ecosystems, including coral reefs and seagrass meadows.

These projects have engaged local communities in restoring these ecosystems damaged by climate change and human activity; and *iii)* Resilience initiatives in Indian Ocean Islands, where countries like Seychelles and Mauritius have established marine reserves and promoted sustainable fishing practices as part of their climate resilience strategies. These efforts aim to protect marine biodiversity and ensure food security for island communities.

Theoretical-Methodological Framework, the theory of ecological resilience represents a fundamental cornerstone in the research and understanding of the relationship between natural systems and climate change. This theory focuses on the capacity of ecosystems to withstand disturbances, recover from adverse impacts, and adapt to changing conditions over time. In essence, ecological resilience posits that natural systems are not static but dynamic and adaptable. These systems can face significant challenges, such as rising temperatures, biodiversity loss, and habitat degradation, yet still maintain their integrity and essential functions (Holling, 1973).

Research based on the theory of ecological resilience not only helps us better understand how ecosystems operate in a changing world but also provides valuable insights for informed decision-making. This theory demonstrates how people can intervene in nature to address the challenges of climate change, protect our natural resources, and build a more sustainable future for future generations. It is, in essence, an essential foundation for the conservation and resilience of our planet in the context of ongoing climate change (Holling, 1986).

The theoretical approach followed is grounded in: *a)* C. S. Holling, one of the founders of resilience theory, has played a pivotal role in conceptualizing and developing this theory. His pioneering work has contributed to understanding ecosystem dynamics, promoting the theory, and its application in natural resource management and conservation (Holling et al., 1998), and *b)* Lance H. Gunderson, another prominent expert in resilience theory. He has focused his research on applying resilience in ecosystem management and environmental decision-making (Chaffin & Gunderson, 2016).

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As for the study area, from the 1940s to the present, Mexico's governmental policy has focused on protecting the country's natural and cultural heritage. This approach has led to the designation of 185 Federal Protected Natural Areas (Áreas Naturales Protegidas or ANPs), in addition to other areas with protection status at the state, municipal, and community levels (Comisión Nacional de Áreas Naturales Protegidas, 2022).

These protected natural areas play a vital role in global conservation efforts. They not only significantly contribute to improving the quality of the environment by promoting air oxygenation and preserving biodiversity but also serve an essential function as spaces for spiritual well-being, hiking activities, and other forms of recreation and tourism.

In terms of the local historical context, it dates back to 1982 when La Roqueta Island was declared a Marine National Park by then-President of the Republic, Lic. José López Portillo (Diario Oficial de la Federación, 1982). However, in 1998, the Coordination of Protected Natural Areas of the National Institute of Ecology of Mexico recommended to the Government of Guerrero "that custody of the Environmental Management Unit (UMA) La Roqueta be transferred to the Secretary of the Navy and the administration of this area to the municipality of Acapulco through the municipal offices of Tourism and Ecology" (Niño Gutiérrez, 2012, p.13).

Environmental education is the process of sensitizing individuals and the community at large to the state of the environment and its close relationships with socio-economic and cultural aspects (Niño Gutiérrez, 2014), promoting awareness of the environment and its resources, instilling values, imparting knowledge, developing skills, experiences, and the will to solve specific problems in daily life and adopting a sense of solidarity with fellow humans, the environment, and oneself (Santamaría and Guevara, 2017, Table 1).

Education axis	Environmental education
Priority	Environmental sustainability and resilience
Objective	1.1 Development of resiliencie activities
	1.2 Fostering recovery and adaptation to climate change
Estrategies	Establishing a commitment to island conservation and responsable use of *water, soil, and vegetation*
	1.2.1 Strengthening resilience-focused actions for climate change *resistance, recovery, and adaptation*
Action	1.1.1.2 Promoting non-formal environmental education and citizen participation in the conservation of the island landscape
	1.2.1.1 Promoting island resilience in print media, radio, televisión, and scientific articles

Table 1 Proposal for a non-formal and inclusive environmental education program on Roqueta Island in Acapulco
Source: Author's own work

Roqueta Island serves as a green lung for the residents of the city and port of Acapulco, Guerrero (Figure 1). It holds significant social relevance as it was the site of the first amphibious battle with simultaneous action at sea and on land in the struggle for Mexico's Independence on June 13, 1813 (Secretaría de Marina, 2022).

Figure 1 Civic engagement on Roqueta Island
Source: Self-captured

The island covers an area of 1.16 km^2, with a tropical climate featuring summer rains (Aw), 286 sunny days per year. It serves as a nesting and refuge site for marine birds, mammals, and reptiles (Aguirre et al., 2010). However, it is currently vulnerable due to the absence of a management program.

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Its environmental significance lies in being a natural refuge for fauna such as raccoons (*Procyon lotor*), green iguanas (*Iguana iguana*), black iguanas (*Ctenosaura pectinata*), white-faced magpies (*Calocitta formosa*), ospreys (*Pandion haliaetus*), orange-fronted parakeets (*Eupsittula canicularis*), peregrine falcons (*Falco peregrinus*), Cooper's hawks (*Accipiter cooperii*), masked woodpeckers (*Melanerpes chrysogenys*), yellow-crowned night herons (*Nyctanassa violácea*), and white-tailed hawks (*Butteo albonotatus*). Additionally, it features low deciduous forest vegetation, including amate (*Ficus insípida*) and ceiba (*Ceiba pentandra*) trees that grow to heights exceeding 20 meters (Ochoa, 2021).

Results

Since 1948, tourist activities have been developed in a chaotic manner. Hence, the purpose of this study is to contribute to the proposal of a non-formal environmental education program on Roqueta Island in Acapulco, Guerrero, Mexico (Niño et al., 2021). The aim is to provide residents, domestic tourists, and foreign visitors with environmental knowledge about the importance of conserving this natural space (Figure 2).

Figure 2 Promotion of local environmental education
Source: self-captured

The results revealed that: *a)* Acapulco Bay is constantly impacted by tropical storms and high waves; *b)* La Roqueta Island serves as a green lung in Acapulco, Guerrero, Mexico, but its land-sea interface is altered due to the activities of intensive tourism (Gobierno de México, 2022a); and *c)* local environmental management, including conservation (resistance) and restoration (recovery and adaptation) actions carried out by the local population as positive intervention measures, sometimes with the cooperation of tourism concessionaires, have contributed to extending the possibility of an environmental collapse over time (Niño-Gutiérrez, 2023, Table 1).
Environmental education contributes to balance in the affective, value, cognitive, or behavioral aspects of global citizens, with significance in the personal learning process (Placensia et al., 2021). Therefore, it is suggested that educational activities on the island include environmental education, ecology workshops, and thematic tours. Additionally, conservation activities should be undertaken, including reforestation campaigns, garbage collection, and awareness-raising about caring for the environment in the fragile island ecosystem. These actions help reduce the negative impacts of urban solid waste, improper freshwater management, and the alteration of the low deciduous forest, among other issues (Arroyo & Lechuga, 2021).

Hence, the importance of proposing the program: "Environmental resilience in Roqueta: Our path to a sustainable future," whose overall objective will be: To promote resilience and sustainability on the island through environmental education, by training tourism service providers, residents, and visitors to address the challenges of climate change (Niño-Gutiérrez, 2022b). An example of content could be: Module 1: Strengthening Resilience.

Resistance action: Restoration of marine ecosystems: Lesson 1: Introduction to marine ecosystems and their importance; Lesson 2: Impacts of climate change on coral reefs; Lesson 3: Restoration projects and their impact on marine biodiversity; and practical activity: Participation of various actors in restoration activities (Periódico Oficial del Gobierno del Estado de Guerrero, 2009).

Specific objective: Upon completing the program, participants will be equipped to identify the impacts of climate change on their island communities and take concrete steps to enhance their resilience, restore their environment, and adapt to climate change. Methodology: The program will be conducted in the form of interactive workshops, practical field activities, and community projects. Certification is not necessary as it is non-formal education. This educational program will help visitors, tourism service providers, and island residents understand and effectively address the challenges of climate change, promoting resilience and sustainability in their unique environment (Kabir et al., 2018).

In this context, the theory of ecological resilience stands as a fundamental pillar for understanding how ecosystems can face and recover from natural and anthropogenic disturbances related to climate change (Groch & Cogliati, 2022). It is important to emphasize that resilience, especially in islands and coastal communities like Roqueta Island, plays a crucial role (Niño Gutiérrez, 2012). In this case, the discussion focuses on how resistance, recovery, and adaptation actions are essential to strengthen the island's resilience (Table 2).

Resistance activities	Recovery activities	Adaptation activities
Collection of food and urban waste	Cleaning of the marine and terrestrial bottom	Collaborating with various stakeholders to disseminate information about natural disaster preparedness measures
Safeguarding biodiversity	Cigarette butt collection	Monitoring and protecting endemic species of parakeets, green iguanas, and black iguanas to ensure their survival
Preserving unique habitats on the island	Generating scientific knowledge to support informed decision-making regarding biodiversity and climate change.	Involving entrepreneurs in decision-making and planning for a sustainable future
Strengthening effective communication on environmental issues and climate change adaptation	Empowering students from Elementary to undergraduate levels to become advocates for local environmental conservation	
Documenting and understanding species diversity on Roqueta island		

Table 2 Climate change adaptation activities on Roqueta Island in Acapulco, Guerrero
Source: Author's own work

Conclusions

A) The expansion of an inclusive environmental education program on the island is an indispensable priority. This program not only has the potential to promote the sustainable use of the abundant natural resources on the island but can also foster a deeper connection with the values and scenic charms of the environment. Of particular relevance is the ability to involve children and youth in the stewardship and preservation of the environment; *B)* It is essential to disseminate and obtain the consensus of authorities related to the tourism and ecological sectors, as well as non-governmental organizations, regarding the incorporation of actions from the inclusive environmental education program into local environmental protection strategies and policies. This synergy can generate tangible benefits, such as a noticeable improvement in the island's environmental surroundings and *C)* Despite the fact that the population of La Roqueta has implemented resistance, recovery, and adaptation measures in the right direction, they are still considered insufficient compared to the magnitude of the challenges they face. Continued collaboration and the expansion of these measures are crucial to successfully address ongoing climate and environmental challenges. These conclusions summarize the main findings and recommendations derived from the study regarding Roqueta Island and its environment (Gobierno de México, 2022b).

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Postpartum reproductive efficiency of hair breed sheep additioning bypass fat and a gluconeogenic ingredient

Eficiencia reproductiva postparto de ovejas de pelo adicionando grasa de sobrepaso y un ingrediente gluconeogénico

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Abstract

The aim of this study was to evaluate the effect of to addition the fat by pass and propionate calcium on resumption of the postpartum activity of hair-breed ewes suckling to theirs lambs. A total multiparous of 80 multiparous just lambing ewes with body weight 48±10 kg, were assigned to one of four treatments under randomized complete desing: 1) AC: Continuos suckling without the addition ingredient in your diet (n=22). 2) ACG: Continuos suckling+10 g fat by pass in the diet (n=20). 3) ACP: Continuos suckling+15 g propionate calcium in the diet (n=18) and 4) ACGP: Continuos suckling+10g fat by pass+ 15g propionate calcium in the diet (n=20). The results showed that the treatments presented similar (P>0.05) response to estrus, onset to estrus, return rate, gestation rate, lambing rate, prolificacy and fecundation. It is highlighted that ewes respond favorably to the syncronization protocol initiated at 25 days postpartum even if the ewes are continuosly suckling their lambs. The supplementation with by pass fat or calcium propionate did not affect the reproductive variables evaluated for the resumption of postpartum reproductive activity in hair sheep.

Fat protected, Prolificacy, Calcium propionate

Resumen

El objetivo de este estudio fue evaluar el efecto de la suplementación de grasa de sobrepaso y propionato de calcio sobre el reinicio de la actividad reproductiva postparto de ovejas de pelo que se encuentran amamantando a sus corderos. Se utilizaron un total de 80 ovejas multíparas recién paridas con un peso promedio de 48±10 kg, que fueron asignadas aleatoriamente bajo un diseño completamente al azar a uno de cuatro tratamientos: 1) Amamantamiento continuo (AC, n=22), ovejas lactando no recibieron algún ingrediente en su dieta. 2) Amamantamiento continuo + grasa (ACG, n=20), ovejas lactando recibieron 10 g de grasa/oveja en su dieta. 3) Amamantamiento continuo + propionato (ACP, n=18), ovejas lactando recibieron 15 g de grasa/oveja en su dieta y 4) Amamantamiento continuo + propionato + grasa (ACGP, n=20), ovejas lactando recibieron 10g de grasa + 15 g de propionato de calcio/oveja en su dieta. Los resultados demostraron que los tratamientos presentaron similar (P>0.05) respuesta al estro, inicio al estro, tasa de retorno, tasa de gestación, tasa de parto, prolificidad y fecundación. Se destaca que las ovejas responden favorablemente al protocolo de sincronización iniciado a los 25 días postparto incluso si las ovejas se encuentran en amamantamiento continuo. La suplementación con grasa de sobrepaso o propionato de calcio no afectaron las variables reproductivas evaluadas para el reinicio de la actividad reproductiva postparto de ovejas de pelo.

Grasa protegida, Prolificidad, Propionato de calcio

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Introduction

The population of hair sheep has been increasing in the last years in the American continent with a wide distribution, not being reduced only to tropical regions as previously thought; nowadays hair sheep are distributed from tropical regions as well as in temperate and arid regions (McManus et al., 2010). In Mexico, Pelibuey sheep or their crosses with Dorper and Kathadin are the main hair sheep genotypes distributed in the national territory (Chay-Canul et al., 2016). This is due to their ability to adapt to different climates and the low reproductive seasonality of these sheep. Thanks to this, it is possible to develop reproductive programmes throughout the year (Arroyo, 2011) and these breeds are considered an alternative to cover the country's demand for sheep meat (Herrera-Corredor et al., 2010). However, it is necessary to improve their reproductive parameters to achieve this objective; one of the strategies to achieve this is proper postpartum management; a tool that has been used to minimise the time of the restart of postpartum ovarian activity, increase flock productivity and the economic condition of producers (Morales-Terán et al., 2004). However, newly lambed ewes suffer severe metabolic stresses when transitioning from a non-lactating to a lactating state of gestation; therefore nutritional management is of paramount importance at this point (Babaei et al., 2019). Nutrition has been shown to be an important factor that can modify reproductive behaviour (Ashworth et al., 2009). In this regard, energy supplementation by including various energy ingredients, such as protected oils and fats, has been chosen at different physiological stages for different purposes

(Holst et al., 2005; Radunz et al., 2009; Raju et al., 2015; Bhatt and Sahoo, 2017; Lerma-Reyes et al., 2018; Haro et al., 2020) the purpose is to increase energy in the diet without increasing the proportion of grains avoiding ruminal acidosis (Silva et al., 2011). On the other hand, the inclusion of glucose precursors has increased in ruminants, such as calcium propionate and glycerol as they have been shown to optimise nutrient utilisation and improve production (Avila et al., 2011; Lee-Rangel et al., 2012; Avila-Stagno et al., 2013; Mendoza-Martínez et al., 2016; Miranda et al., 2017; Cifuentes-López et al., 2018).

However, the use of both has not been studied in the postpartum period of hair ewes, for the restart of postpartum ovarian activity. Therefore, the aim of this study was to evaluate the inclusion of top fat and calcium propionate in the postpartum ovarian restart of hair ewes while they were suckling their lambs.

Methodology

Location

The present work was carried out at the Montecillo Campus of the Colegio de Postgraduados, in the facilities of LaROCa (Sheep and Goat Reproduction Laboratory), located in Texcoco de Mora, State of Mexico. Geographically located between the coordinates 19º 27'51.90" N latitude and 98º 54'34.30" W longitude at an altitude of 2250 m. With 644.8 mm of annual rainfall and an average temperature of 15º C (García, 2004).

Animals, management and treatments

A total of 80 recently lambed hair ewes at the end of July 2019, were used; with an average weight of 48±10 kg at lambing. Ewes with their offspring were randomly allocated to one of 4 treatments using a completely randomised design.

The ewes remained in continuous suckling with their lambs throughout the experiment, i.e. the lambs remained with their mothers 24 hours a day. The treatments consisted of the addition or not of some energy ingredient in the diet of the lactating ewes during the synchronization protocol; which was carried out 25 days after lambing, for the resumption of postpartum ovarian activity. 1) Continuous suckling (AC, n=22), lactating ewes did not receive any ingredient in their diet. 2) Continuous suckling + fat (ACG, n=20), lactating ewes received 10 g of surplus fat / ewe in their diet. 3) Continuous suckling + propionate (ACP, n=18), lactating ewes received 15 g calcium propionate / ewe in their diet and 4) Continuous suckling + propionate + fat (ACGP, n=20), lactating ewes received 10 g fat + 15 g calcium propionate / ewe in their diet.

Feeding

Ewes were fed a balanced diet according to their requirements (2.3 Mcal/kg DM of ME and 15% CP), as recommended (NRC, 2007).

For the treatments with propionate or fat surplus, this ingredient was added directly to the diet (Table 1).

The experimental diets were offered when the oestrus synchronization protocol had already started; from day 5 to day 9, i.e. they were offered for 5 days.

Water was available ad libitum throughout the study.

Ingredient (Kg)*.	Treatments			
	AC	ACG	ACP	ACGP
Wheat straw	40	36	40	36
Alfalfa	29	25	29	25
Concentrate	20	20	20	20
Corn	5	5	5	5
Fat	0	0.50	0	0.50
Calcium propionate	0	0.75	0	0.75
Minerals	1	1	1	1
Molasses	5	5	5	5
*Portions offered on an as offered basis per kg of dry matter.				

Table 1 Ingredients in experimental diets offered to hair ewes

Oestrus synchronization protocol

The synchronization protocol consisted of insertion of an intravaginal device (CIDR, Controlled Internal Drug Release; with 0.3 g progesterone, Pfizer) into the ewe for 9 days from day 25 post parturition. 48 h before withdrawal, 1 mL ewe-1 of prostaglandin (PGF2, Dinoprost; Lutalyse, Pharmacia & Upjhon, Michigan, USA) was applied intramuscularly. After 48 h, the CIDR was removed and oestrus was detected every 4 h for 72 h with the help of male guards wearing aprons to avoid copulation with the female.

Artificial insemination (AI)

Prior to artificial insemination, semen was collected and evaluated from healthy and reproductively fit rams. Artificial insemination (AI) was carried out 12 to 18 hours after the ewes had shown oestrus.

The ewes were shaved and disinfected in the abdominal region. Subsequently, insemination was carried out using the abdominal laparoscopy technique, in which a 0.25 mL straw of semen was introduced, depositing half of the straw in each uterine horn.

Diagnosis of pregnancy

Gestation diagnosis was made at 35 days post-service with a portable ultrasound (Aloka SSD 500, 7 Mhz transducer).

Reproductive variables

The following reproductive variables were used to assess the resumption of postpartum ovarian activity in ewes.

Oestrus response

Number of ewes showing signs of oestrus after removal of the device relative to the total number of ewes in each treatment.

$$\%Estro = \frac{No.de\ ovejas\ que\ presentaron\ estro}{No.total\ de\ ovejas\ por\ tratamiento} \times 100 \quad (1)$$

Onset of oestrus

Interval between removal of CIDR and onset of oestrus. The distribution was determined by the number of ewes that went into oestrus up to 72 hours after removal of the CIDR.

Return to oestrus

Number of ewes showing return to oestrus at 17 or 34 days post-insemination.

$$\%Retorno = \frac{No.de\ ovejas\ que\ presentaron\ retorno\ a\ estro}{No.total\ de\ ovejas\ por\ tratamiento} \times 100 \quad (2)$$

Gestation rate

Number of ewes diagnosed pregnant in relation to total number of ewes per treatment.

$$\%Gestación = \frac{No.\ de\ ovejas\ gestantes}{No.\ total\ de\ ovejas\ por\ tratamiento} \times 100 \quad (3)$$

Lambing rate

Number of ewes lambed to total number of ewes per treatment.

$$\%Parto = \frac{No.\ de\ ovejas\ paridas}{No.\ total\ de\ ovejas\ por\ tratamiento} \times 100 \quad (4)$$

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Fertility

Total number of lambs born to the total number of ewes per treatment.

$$\%Fecundidad = \frac{No.de\ corderos\ nacidos}{No.total\ de\ ovejas\ por\ tratamiento} \times 100 \quad (5)$$

Prolificacy

Number of lambs born to number of ewes lambed per treatment.

$$Prolificidad = \frac{No.de\ corderos\ nacidos}{No.total\ de\ ovejas\ por\ tratamiento} \times 100$$

Statistical analysis

The statistical package (SAS, 2012) was used for statistical analysis of the data. Significant differences were considered at P<0.05. Logistic regression using PROC LOGISTIC was used for the variables oestrus response, return to oestrus, gestation rate and lambing rate. The prolificacy and fecundity variables were analysed using a POISSON distribution using PROC GENMOD. The Shapiro and Wilk test (Shapiro and Wilk, 1965) was used for the variable onset of oestrus to observe univariate normality and then the analysis was carried out with the Kaplan Meier survival curve method using the Log-Rank test, with the LIFETEST procedure.

Results and discussion

The results obtained in this experiment on the resumption of ovarian activity in hair ewes during postpartum due to the effect of supplementation are shown in table 2.

Trat	n	Oestrus (%)	Return (%)	Gestation rate (%)	Lambing rate (%)	Prolificacy	Fertility
AC	22	45.5 [a] (10/22)	0 [a] (0/22)	45.5 [a] (10/22)	45.5 [a] (10/22)	1.1 [a]	0.5 [a] (11/22)
ACG	20	40 [a] (8/20)	0 [a] (0/20)	40 [a] (8/20)	40 [a] (8/20)	1.1 [a]	0.5 [a] (9/20)
ACP	18	55.6 [a] (10/18)	16.7 [a] (3/18)	50 [a] (9/18)	50 [a] (9/18)	1.4 [a]	0.7 [a] (13/18)
ACGP	20	45 [a] (9/20)	15 [a] (3/20)	45 [a] (9/20)	45 [ab] (9/20)	1.0 [a]	0.5 [a] (9/20)

AC: Continuous suckling, ACG: Continuous suckling + Fat, ACP: Continuous suckling + Propionate, ACGP: Continuous suckling + Fat + Propionate.
a,b Different letters indicate differences between treatments at P<0.05.

Table 2 Reproductive variables evaluated in the postpartum period of hair ewes

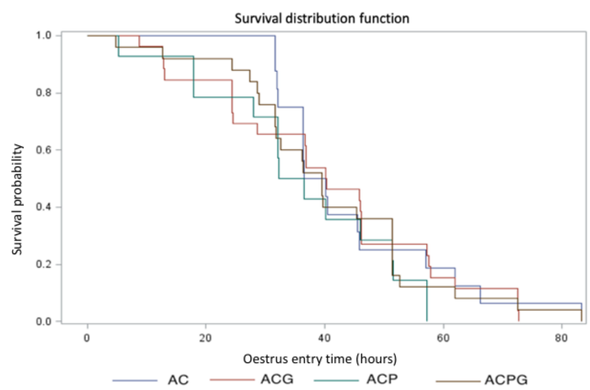
Supplementation with fat or calcium propionate during the synchronization protocol did not affect (P>0.05) the percentage of ewes in oestrus. Although some ewes did respond to the synchronization protocol whi lambing rate started at 25 days postpartum, a low oestrus incidence rate of less than or equal to 55% was observed in the 4 treatments.

Similarly, for the variables return rate, gestation rate and lambing rate, the treatments had no significant differences (P>0.05).

Graphic 1 shows the survival curves of the distribution of the hours of onset of oestrus for each treatment.

It can be seen that the variable onset of oestrus was not affected by the addition of top fat or calcium propionate.

However, it can be seen that the treatment with the addition of calcium propionate was the treatment that went into oestrus at an average of 60.68 hours.



Graphic 1 Oestrus onset survival curves formed by Kaplan-Meyer survival estimators at different times per treatment (P<0.05)
AC: Continuous suckling, ACG: Continuous suckling + Fat, ACP: Continuous suckling + Propionate, ACGP: Continuous suckling + Fat + Propionate.
Source: SAS, 2012

Although no significant differences were found in the prolificacy and fecundity variables (P>0.05), propionate promises to be a window of opportunity for the resumption of postpartum ovarian activity.

The results of the present work are not similar to those found in another study from the same research in which, in contrast to these results, all ewes responded favourably to the synchronization protocol showing signs of oestrous behaviour.

This could be related to the presence of negative energy balance (NEB) in the ewes, as NEB is associated with suppression of reproductive function and ovarian cyclicity (Crown et al., 2007; Hill et al., 2008; Crowe et al., 2014).

Energy deficiency especially during critical physiological stages has been shown to negatively affect growth, milk production and subsequent reproduction (Horton et al., 1992).

Therefore, the idea of using supplementation was to increase efficiency and nutrient uptake to improve postpartum reproduction of ewes; as (Haro et al., 2020) did to improve animal production. Supplementation with various gluconeogenic ingredients or protected fats has been shown to have good results (Mahouachi et al., 2004; Abdalla, 2013; Silva et al., 2011; Pérez-Hernández et al., 2009a; Mejía Vázquez et al., 2017). The use of protected fats in the diet of ewes has had variable results; in this research work the ewe received 10 g of fat supplementation per day, which is a lower amount than what (Kumar et al., 2006) incorporated palm oil calcium soaps (10%) in the diet of growing lambs and it had no adverse effects on growth and carcass characteristics of the lambs.

Some studies report that the inclusion of fatty acids has been unable to alter the size or number of follicles by dietary effect (Molina-Mendoza et al., 2013), consequently if follicles do not grow, they will not be able to secrete oestradiol, necessary for females to show oestrus behaviour, possibly this occurred with the ewes in this experiment.

On the other hand, negative effects on fibre intake and digestibility have been reported with the addition of fat, so only 3-5% is allowed in the diet, as this is the maximum level that rumen micro-organisms can tolerate (Bayourthe et al., 1993).

In the case of calcium propionate, (Cifuentes-López et al., 2018) added (40 g/kg DM) to finishing lambs on alfalfa-based diets did not affect feed intake or live weight, but improved performance and desirable carcass attributes in finishing lambs. However, based on the above information, we cannot compare the results, because the animals in which the studies were carried out, including this one, were at different physiological stages and were even carried out on sheep of different sexes. But in general, it can be observed that the supplementation of fat and calcium propionate have had good results in the inclusion of sheep diets.

Nutrition is considered a possible environmental factor capable of affecting not only oocytes and embryos in their immediate environment, but also changes in the environment in which the female lives, during the breeding season and in early gestation. Such changes can generate effects that will result in offspring, including reproductive behaviour in subsequent generations (Ashworth et al., 2009). Possibly, in this study, supplementation for 5 days with either top-up fat or calcium propionate was not able to fully counteract the negative energy balance, which is known to be one of several factors that can significantly affect the resumption of postpartum ovarian activity (Pérez-Hernández et al., 2009b).

In a study by (Babaei et al., 2019) they suggest gradually increasing energy levels, in this case grain, specifically maize in diets to improve feed intake of ewes during peripartum to reduce the severity of the negative energy balance during this period. It follows from the above that research is still being carried out with traditional ingredients that provide energy, but this does not mean that grains are cheap and affordable for producers.

That is why ingredients that can partially replace grains in critical stages are sought in the cheapest possible way, with excellent results. However, it must be considered that although the ewes did not show the expected results to the supplementation of energy supplements, this could be a consequence of the management of the ewes, because although they did not respond to the supplementation, they did come into heat, in addition to reaching lambing, that is, good management is probably key to the success in a good reproductive efficiency of the flock.

On the other hand, it is known that the restart of ovarian activity takes place thanks to the participation of some hormones, neurotransmitters and proteins (Lozano et al., 1998; Dobek et al., 2013; Crowe et al., 2014). Endogenous opioid peptides (EOPs) are neurotransmitters that are synthesised during lactation and their activity is to regulate the secretion and release of GnRH (Russell, 2008; Arroyo et al., 2009), the absence of this hormone causes the inhibition of ovarian activity by delaying the growth of follicles that fail to mature (Arroyo et al., 2009).

It should be noted that during the present study the ewes were in continuous suckling and the secretion of opioids could have an effect on the ewes that did not respond to the synchronization protocol, regardless of the fact that the dates on which this study was carried out were during the reproductive season.

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Seasonal variation in the concentration of phenolic compounds in bee honey

Variación estacional en la concentración de compuestos fenólicos en miel de abeja

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Abstract

The phenolic compounds in honey provide healthy properties to this food. These products have been studied due to their ability to inhibit and reduce the production of free radicals, which cause oxidative damage to molecules. This research aimed to determine the concentration of antioxidants in *Apis mellifera* honey harvested during winter and spring in the Huasteca Veracruzana region. To assess the honey, 16 samples were collected and diluted (1:5 w/v) to quantify the total phenol content by the Folin-Ciocalteau method; flavonoids according to Kubola and Syriamonrpun; antioxidant capacity through FRAP and ABTS assays adapted to microplates. One-way ANOVA was performed considering the season of the year as a variation factor. Homogeneity was evaluated with Bartlett, normality with Shapiro-Wilk and the comparison of means with Tukey ($p < 0.05$). The concentration of phenols, flavonoids, FRAP and ABTS was higher in the spring season ($p < 0.05$). The content of flavonoid in samples harvested in spring was 0.562 mg QE/100 g^{-1}; while those collected in winter the was 0.502 mg QE/100 g^{-1}. These differences could be attributed to the availability of flora between these seasons.

Antioxidants, Phenols, Flavonoids

Resumen

Los compuestos fenólicos en la miel de abeja, proporcionan propiedades saludables a este producto alimenticio; éstos han sido estudiados debido a su capacidad para inhibir y reducir la producción de radicales libres, los cuales ocasionan daños oxidativos en las moléculas. El objetivo de esta investigación fue determinar la concentración de antioxidantes presentes en la miel de *Apis mellifera* cosechada durante invierno y primavera en la Huasteca Veracruzana. 16 muestras fueron colectadas y diluidas (1:5 p/v), para cuantificar el contenido total de fenoles por el método Folin-Ciocalteau; flavonoides de acuerdo con Kubola y Siriamonrpun (2011); capacidad antioxidante a través de ensayos FRAP y ABTS adaptados a microplacas. Se realizó ANOVA de una vía considerando como factor de variación la estación del año. La homogeneidad se evaluó con Bartlett, normalidad con Shapiro-Wilk y la comparación de medias con Tukey ($p < 0.05$). La concentración de fenoles, flavonoides, FRAP y ABTS fue mayor en la estación de primavera ($p < 0.05$), en el caso particular del contenido de flavonoides en miel cosechada en primavera se estimó un contenido de 0.562 mg EQ/100 g^{-1} mientras que la de invierno 0.502 mg EQ/100 g^{-1}. Estas diferencias podrían atribuirse a la disponibilidad de flora entre estaciones.

Antioxidantes, Fenoles, Flavonoides

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Introduction

Honey is defined as a sweet, natural food that is generated from the nectar of plants, which is collected and transformed by bees. According to the floristic resource it can be classified as monofloral (where a single floral species predominates), multifloral or polyfloral (representing different floral species), and honeydew (coming from secretions of living parts of plants) (Martínez et al., 2017).

Honey is in great demand on the international market thanks to its nutritional value and its therapeutic and stimulating qualities (Escobar and Manresa, 2005). It is made up of carbohydrates, with monosaccharides such as fructose and glucose, disaccharides such as sucrose, trisaccharides such as melecithiose, and oligosaccharides, water, minerals, amino acids, proteins and organic acids. Their composition may depend on factors such as floral species, soil, species, colony physiology, among others (Bogdanov et al., 2008; Jean-Prost, 2007). Polyphenolic compounds, such as phenolic acids and flavonoids, are known to be the constituents responsible for the health-promoting properties provided by honey. These compounds are able to inhibit and/or reduce the production of oxidative compounds, also known as free radicals that can cause oxidative damage to molecules such as carbohydrates, lipids, proteins and their genetic material (Nascimento et al., 2018). These chemicals produced by plants have been studied due to their antioxidant, antimicrobial, anti-inflammatory and other health effects (Viuda-Martos et al., 2008). The objective of this research was to determine the variation in the concentration of antioxidants present in Apis mellifera honey harvested during winter and spring in the Huasteca Veracruzana.

Methodology

This research was carried out in the Huasteca region of the state of Veracruz, which lies between parallels 97º 59' and 98º 24' west longitude and 21° 06' and 21° 40' north latitude. This region has a warm sub-humid climate with summer rainfall and an annual precipitation of around 1100 mm. Relative humidity can reach values of 64% and the average annual temperature ranges between 22 - 26 ºC. (INEGI, 2021).

The main productive activities in the region are cattle raising and agriculture, focused on the production of corn, citrus fruits and sugar cane. Other crops of equal importance for the regional economy are sesame, peanuts, courgette, sweet potato, beans, watermelon, sorghum, wheat (in Huayacocotla), soybean (Pánuco), tobacco, tomato, coconut, mango and papaya. In some municipalities there are important fragments of mesophyll forest, pine forest and medium forest in the lower elevations of the mountain range. There are also important fragments of mangrove and hydrophilic vegetation distributed in some municipalities (INEGI, 2021).

Sixteen samples were collected from different apiaries during two seasons in the municipality of Tantoyuca, Veracruz. From each apiary, one hive was selected from which a hive frame was taken to an extraction room, where it was castrated and introduced into a manual extractor to avoid contamination of the honey. An approximate volume of 500 mL was obtained from each apiary, which was packed in jars wrapped with aluminium to avoid the entry of light, labelled and stored at room temperature until analysis. The concentration of phenols, flavonoids and antioxidant capacity by FRAP and ABTS assays were evaluated in vitro using honey solutions (1:5 w/v) in the Natural Products Laboratory of the Agricultural Preparatory Department at the Autonomous University of Chapingo. Phenolic content was determined according to Singleton and Rossi (1965), by the Folin-Ciocalteau method. The calibration curve was prepared from a solution of gallic acid. The absorbance was measured at 760 nm, the results were expressed milligrams of gallic acid equivalents per 100 g of honey. (mg GAE/100 g^{-1}). Total flavonoid content was quantified using the technique supported by Kubola and Siriamonrpun (2011) with some modifications in sample preparation. An aliquot of the 1:5 solution (0.5 mL) was mixed with 0.1 mL of 10% $AlCl_3$ $6H_2O$ and 0.1 mL of 1M CH_3CO_2K. The calibration curve was prepared for quercetin, and the results were expressed as milligrams quercetin equivalents per 100 g honey. (mg QE/100 g^{-1}). Antioxidant capacity was calculated by means of FRAP and ABTS assays performed under the protocol described by Benzie and Strain (1996) and Re et al. (1999), adapted to microplates.

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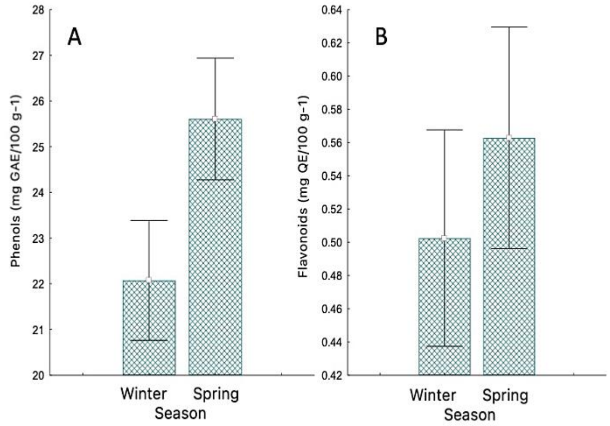
Calibration curves for Trolox (6-hydroxy-2,5,7,8-tetramethylchroman2-carboxylic acid) were prepared at a concentration of 0.25 mg/mL^{-1}, and data were reported in µmol Trolox equivalents per 100 g of honey (µmol TE/100 g^{-1}). One-way ANOVA was performed considering season as a factor of variation. Homogeneity was evaluated with Bartlett, normality with Shapiro-Wilk and comparison of means with Tukey ($p < 0.05$).

Results

The total phenol and flavonoid contents of the samples analysed during two seasons are shown in Table 1. Table 1 shows that the phenolic and flavonoid content was higher in spring, showing a statistical difference ($p < 0.05$) on the phenolic values obtained from the winter samples compared to the spring samples (Figure 1A and 1B). The difference among the concentrations of these compounds could be due to the greater availability of floristic resources during spring. These results are similar to those reported by Avila-Uribe et al. (2020), who evaluated honey samples from different municipalities in the state of Quintana Roo, where the bee floristic composition was characterised by a marked difference, which is attributed to the sampling site. Their results show that floristic characteristics influenced the concentration of phenolics and flavonoids. The samples they analysed showed values of 27.85 ± 0.045 mg GAE/100 g^{-1} and 5.75 ± 0.31 mg QE/100 g^{-1} respectively.

Station	Phenols mg GAE/100 g^{-1}	Flavonoids mg QE/100 g^{-1}
Winter	22.074^{b}	0.502^{b}
Spring	25.605^{a}	0.562^{a}
Standard error	0.565	0.018
Means per column with different literals show statistical difference (Tukey p < 0.05).		

Table 1 Concentration of total phenols and flavonoids in winter 2022 and spring 2023 bee honey.



Graphic 1 Concentration of phenols and flavonoids present in bee honey during the winter 2022 and spring 2023 seasons

On the other hand, Quintero-Lira et al. (2019) in their research on the concentrations of phenols and flavonoids in different regions of the state of Hidalgo, reported that the sampling site associated with the floristic composition was the main factor responsible for the statistical differences between the honey samples evaluated. In their analysis, they report that monofloral honey (*Citrus sinensis*) obtained the lowest concentrations of total phenols 16.61 mg GAE/100 g^{-1} and 97.92 mg QE/100 g^{-1} of phlovonoids.

Station	FRAP µmol TE/100 g^{-1}	ABTS µmol TE/100 g^{-1}
Winter	63.771^{b}	686.41^{b}
Spring	72.182^{a}	984.91^{a}
Standard error	2.746	31.558
Means per column with different literals indicate significant difference (Tukey p < 0.05).		

Table 2 Concentration of total phenols and flavonoids in bee honey from winter 2022 and spring 2023

For both the FRAP and ABTS assays, samples from the spring season showed a higher antioxidant capacity (Table 2). These results were similar to those reported by Ávila-Uribe et al. (2022) in honeys from the state of Quintana Roo, which were 30.55 ± 0.09 - 137.54 ± 0.10 for FRAP and for ABTS 83.97 ± 0.04 - 109.30 ± 0.05 µmol TE/100 g^{-1}. Concentration of total phenols and flavonoids in bee honey from winter 2022 and spring 2023.

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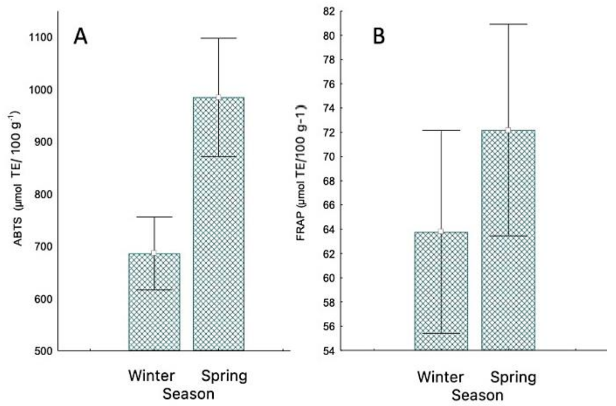

Graphic 2 Antioxidant capacity by FRAP and ABTS assays in honeys produced in winter 2022 and spring 2023

As shown in Figure 2A and 2B, FRAP and ABTS values were higher in spring. The results obtained indicate that the honey produced in the Huasteca Veracruzana does have a certain antioxidant capacity.

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Conclusions

The antioxidant properties of bee honey are a function of the time of the year in which it is produced. The presence of phenolic compounds is higher in spring than in winter.

The concentrations of antioxidant compounds found in the honey produced in the Huasteca Veracruzana, in general, were lower than those found in other places, this being attributed to the environmental conditions and floristic diversity available in each sampling site.

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Design and construction of a model rocket using computer-aid simulation for L1 Tripoli Certification

Diseño y construcción de un modelo de cohete mediante simulación asistida por ordenador para la certificación L1 Tripoli

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Abstract

The present work describes the construction of an experimental rocket using the OpenRocket software as a design tool to generate the dimensions, weight, and geometry of the fuselage structure, fins, nose cone, and rocket motor. The aim is to enable rocket builders to virtually explore different scenarios before physical construction. In the manufacturing of the rocket components, processes and techniques involving fiberglass are employed. Experimental data is obtained at the Tripoli Mexico launch site using a commercial solid fuel type J from Aerotech, with the designation J270W-14A, providing an impulse of 703 Newton-seconds and ensuring an approximate flight altitude of 1430m. To validate the correct functioning of the simulations during the rocket's flight, the data obtained from the simulation are compared with the data collected by the onboard avionics of the rocket manufactured in the laboratory, considering the dimensions provided by the simulator. With this proposed approach, a significant reduction in construction time, cost, design accuracy, and prediction of key parameters is achieved.

Rocket Design, OpenRocket, Experimental Rocket, Simulation Validation

Resumen

El presente trabajo describe la construcción de un cohete experimental utilizando como medio de diseño el software OpenRocket para generar las dimensiones, el peso y la geometría de la estructura del fuselaje, las aletas, la ojiva y el motor del cohete con el objetivo de permitir a los constructores de cohetes explorar virtualmente diferentes escenarios antes de la construcción física. En la manufactura de las piezas que integran al cohete se emplean los procesos y técnicas de fabricación por medio de fibra de vidrio. Para obtener los datos experimentales se emplea el campo de lanzamientos de Tripoli México utilizando como medio propulsor el combustible sólido comercial tipo J de la empresa Aerotech con número J270W-14A, con un impulso de 703 Newton-segundos, garantizando una altura de vuelo aproximada de 1430 m. Para validar el correcto funcionamiento de las simulaciones durante el vuelo de un cohete, se comparan los datos arrojados por la simulación y por la aviónica a bordo del cohete manufacturado en el laboratorio con las dimensiones proporcionadas por el simulador. Con esta propuesta planteada, se logra reducir significativamente el tiempo de construcción, el costo, la precisión del diseño y la predicción de los parámetros de interés.

Diseño de Cohetes, OpenRocket, Cohete Experimental, Validación de Simulaciones

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Introduction

The Tripoli Rocketry Association certification is comprised of three levels, in this case this article focuses on Level 1. The certifications are intended for individuals 18 years of age and older, although there is also a mentoring program for ages 12 to 17. Level 1 involves the design, launch and recovery of a rocket using certified HPR motors with specific impulse range.

A rocket is a space or aerial vehicle designed to propel itself through the controlled expulsion of gases produced by the combustion of propellant through chemical reaction within a combustion chamber. Rockets operate according to Newton's Third Law, which states that for every action, there is an equal and opposite reaction. In terms of rockets, this means that by expelling gases at high speed backward, the rocket is pushed forward (Pimenten Villasmil, 2014; Guerra Avilés, 2022).

The main components are the Nose Cone containing the payload, which can be a satellite, scientific instruments, or even humans. The Fuselage is the main structure of the cylindrical body of the rocket where the recovery system and flight computers are located. The Propulsion System is where the engine and fuel are placed (Guerra Avilés, 2022). Finally, the Control System is used to direct and stabilize the rocket in flight through fins, as seen in Figure 1.

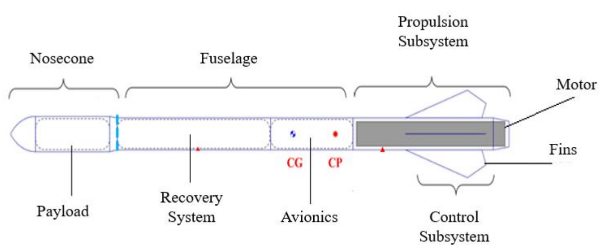

Figure 1 Rocket Architecture Diagram
Source: Own elaboration. OpenRocket

In Mexico, research regarding sounding rockets is scarce, and conducting investigations with these devices is considered highly costly, as there is a tendency to rely on foreign suppliers, significantly increasing expenses. A solution proposed in this research is to create a rocket model where the dimensions, weight, and geometry of each component are generated through simulation for manufacturing in the laboratory.

The use of simulators in rocket construction and design is a common practice in the aerospace industry. Simulators allow engineers to virtually test different configurations and parameters before conducting physical tests, helping to reduce costs and risks associated with rocket development. Additionally, it provides a better understanding of the rocket's behavior under various conditions, leading to more effective and secure designs (Niskanen, 2009).

The simulator to be used is OpenRocket, an open-source simulation software that allows rocket designers to model and simulate rocket flights. The open-source nature enables users to modify and enhance the software according to their specific needs. Its user interface is user-friendly, facilitating data input and rocket design configuration, allowing detailed modeling of rocket components, including body shape, fins, nose cone, motors, and other elements. This provides access to an accurate representation of its geometry. Additionally, it includes an extensive database of commercial rocket motors, making it easy to select and configure specific motors for simulations, thus providing tools to analyze stability and simulate rocket flight under various conditions. This allows users to conduct quick tests and evaluate different design configurations to optimize rocket performance before building the physical model. (OpenRocket)

It also offers visualization capabilities, allowing users to view graphics and visual representations of rocket performance during simulation, providing detailed data on altitude, speed, acceleration, and other flight parameters. This helps understand how the rocket will behave.

On the other hand, having a test field for rocket launches plays a crucial role in ensuring safety. In this context, the Tripoli Rocketry Association (Tripoli Rocketry Association, Inc.) is an international non-profit organization founded in 1964, with a branch in Mexico since 2018 called Tripoli México (Tripoli Rocketry Association, Inc. Mexico).

The goal is to promote the design and construction of rockets. Over the years, it has evolved to become the leading international certification entity, establishing standards and procedures. Rocket certification is essential to mitigate risks and ensure that launches are safe and reliable. Tripoli establishes detailed criteria covering everything from material selection to recovery system verification. This not only protects participants and spectators but also contributes to the advancement of rocket technology.

Tripoli's certification has had a significant impact on the rocket community, fostering a culture of learning and continuous improvement, driving advancements in technology and safety, and contributing to the establishment of global events and competitions such as the Spaceport America Cup (Spaceport America, n.d.). This provides opportunities for undergraduate and graduate students to showcase their skills and creativity.

Finally, the synergy between Tripoli Mexico and the OpenRocket simulation is evident. While Tripoli sets safety standards, the OpenRocket simulator enables builders to virtually explore flight scenarios before physical construction. This not only saves resources but also enhances design accuracy and performance prediction.

The following sections describe the components that make up a rocket, as well as the methodology used to construct a rocket using simulation results related to geometry, dimensions, and weight for physical manufacturing. Finally, to validate the results obtained from the simulation, a field test is conducted by adding a flight computer on board the rocket to provide real-time data on altitude, acceleration, and speed. This allows for a comparison with the simulated data.

Design, Construction, and Launch of a High-Power Rocket

The designed rocket consists of four main sections: the nose cone, the fuselage, the Propulsion Subsystem, and the Control Subsystem. Figure 1 shows the architecture of a rocket.

In general, the thrust section is located at the rear end of the rocket, formed by the fins within the Control Subsystem and the Propulsion Subsystem through the solid fuel motor. The fuselage houses the Flight Computers that will provide flight data such as altitude, speed, and acceleration. The recovery system carries the parachute, which serves as drag to slow down the rocket's speed during descent. At the front end of the rocket, there is the nose cone, which helps reduce air resistance opposing the rocket's movement.

The methodology to be used in this project for the construction of each rocket component will be governed by the simulation results, depending on the geometry, configuration, or initial conditions such as desired altitude, fuselage thickness, rocket height, rocket weight, among others. The simulator will automatically provide us with the dimensions and weight of each component that makes up the rocket, which will be used for manufacturing in the laboratory. Fiberglass is used for the fabrication of all parts since it is known for being a very lightweight, durable, stable material, and an excellent thermal insulator.

At this stage, there may arise the question of why simulation is used to derive the measurements and weights of each rocket component. The answer is that this approach enables the optimization of materials and engines to their maximum potential, aiming to achieve greater altitudes. In essence, by making certain adjustments to the rocket body structure, fins, nose cone, or motor, it is possible to optimize the design to meet the initially set objectives, consequently reducing material and engine costs.

The subsequent section outlines the process for constructing each rocket component.

Nosecone

The nose cone of a rocket is the front part of a model, consisting of a generally conical cover that plows through the fluid medium in which it is immersed during flight. Therefore, it is the component that generates the highest aerodynamic resistance.

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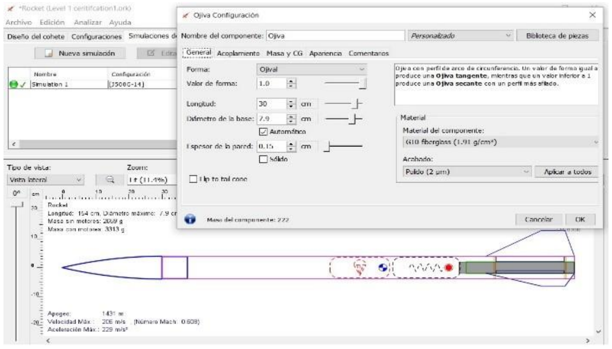

Figure 2. Simulation Result for Rocket Nose Cone
Source: Own Elaboration, OpenRocket

It depends fundamentally on the geometry of the nose cone, in the case of this design we use a tangent type of profile nose cone which is composed of a circle arc, which is tangent to the body of the rocket. Figure 2 shows the result of the simulation of the nose cone in OpenRocket software where it projects the data length, base diameter, thickness, type of fiberglass and weight. With the result of these parameters, the workshop is ready to use to manufacture the nose cone. Starting with the manufacture of the mold and then using the techniques to manipulate the fiberglass (Morales Ortuño, 2008), the nose cone is prepared to be made as shown in Figure 3.

Figure 3 Rocket nosecone manufacturing process
Source: Own elaboration

Fuselage

Rocket fuselages are generally thin-walled smooth cylinders with a high ratio of length to diameter. A cylinder is remarkably strong because the cylinders are structurally efficient, carrying the applied load in such a way that the load is evenly distributed, resulting in a uniform stress level throughout the wall. It houses the engine, recovery system, avionics and sometimes also the payload.

Figure 4 shows the result of the fuselage simulation in OpenRocket software where it projects the data length, outside diameter, inside diameter, cylinder wall thickness, fiberglass type and weight.

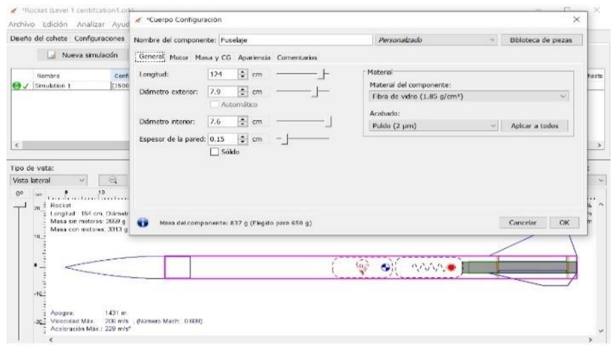

Figure 4 Simulation result for the fuselage
Source: Own elaboration. OpenRocket

With the result of these parameters, an aluminum tube is used as mold to manufacture the cylinder. Once the fiberglass is chosen and cut, the aluminum tube that will be used as a base is cleaned, then a layer of waxed paper is applied in a "spiral" shape that will serve as a divider and separator between the two tubes, making disassembly much easier. Subsequently, techniques are used to manipulate the fiberglass, always taking care that the surface of the cylinder does not wrinkle, bulge or bubble. Figure 5 shows the process used in the manufacture of the rocket fuselage tubes with fiberglass.

Figure 5 Rocket fuselage manufacturing process
Source: Own elaboration

Recovery subsystem

The rocket recovery subsystem is essential to ensure a safe and controlled return of the vehicle after it has reached its highest point in the flight path. This subsystem is responsible for slowing down the rocket and facilitating its safe descent. There may be one or more parachutes, depending on the rocket design and mission requirements.

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The rocket has a dedicated compartment to house the recovery system and a deployment system controls when the parachute is released from the recovery compartment, which can be activated by a timer, an altimeter or an electronic system that senses specific conditions, such as altitude or velocity. For this project, a parachute and a flight computer were used to actuate the recovery system once it detects apogee and free fall.

Figure 6 shows the result of the parachute simulation in OpenRocket software where it projects the data of the diameter, number of ropes, length of the ropes, the material used and the weight of the parachute.

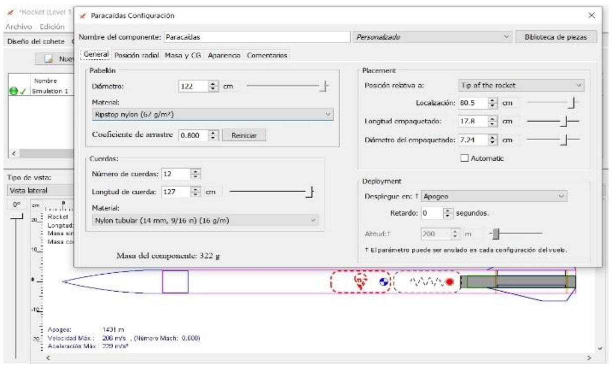

Figure 6 Simulation result for the parachute
Source: Own elaboration, OpenRocket

It is crucial to highlight that parachute manufacturing is a specialized and potentially dangerous activity if not done correctly due to the materials and industrial sewing machines used. Therefore, in this section, the choice was made to select a commercial parachute with the dimensions used, as shown in Figure 7.

Figure 7 Parachute Recovery System
Source: Own elaboration

Avionics

Avionics refers to the electronics used by flight computers or altimeters, playing a crucial role in the design, control, and success of rocket missions. The importance of avionics in rockets is derived from various functions that establish the altitude of the vehicle and initiate certain events at desired altitudes, contributing to the efficiency and safety of the mission. In this project, the Altimeter Two by Jolly Logic (jolly logic) is used. This altimeter provides a rocket flight analysis resulting in 10 key flight performance measurements, including time, date, maximum altitude, maximum speed, motor thrust duration, maximum acceleration, ejection time, and total flight time, as shown in Figure 8.

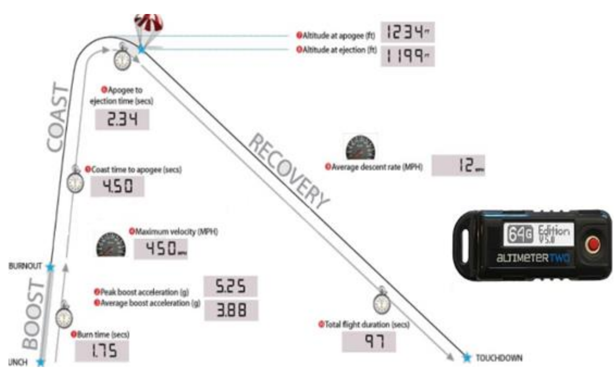

Figure 8 Altimeter and Its Operating Characteristics
Source: Own elaboration

The data provided by the altimeter in the launch field will be used to compare with the simulated data.

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Propulsion subsystem

This subsystem is responsible for providing the necessary energy to propel the rocket. There can be different types of propulsion systems, such as liquid fuel engines, solid fuel engines, or hybrid rocket fuel boosters. The main purpose is to provide the thrust needed to overcome gravity and aerodynamic resistance, allowing the rocket to reach the desired speed and altitude. For this project, the AEROTECH J270W-14A solid fuel motor is used, which has an impulse of 703.0 Newton-seconds (Apogee Components). Figure 9 shows its specifications, and Figure 10 depicts the simulation using the AEROTECH J270W-14A solid fuel motor.

Figure 9 Specifications of the AEROTECH J270W-14A motor
Source: Own elaboration

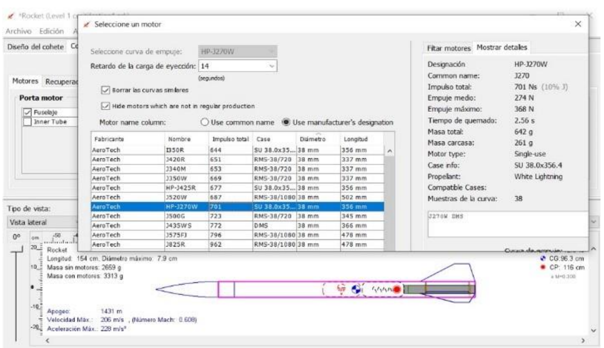

Figure 10 Simulation using the AEROTECH J270W-14 motor
Source: Own elaboration. OpenRocket

Control subsystem

The control subsystem of the rocket is essential to maintain stability, orientation, and direction during its flight. This subsystem utilizes various systems and devices to control and modify the rocket's trajectory as needed. In the case of this project, the fins will remain static, allowing for only a vertical flight.

Fins

The purpose of placing fins on a rocket is to provide stability during flight, allowing the rocket to maintain its orientation and the intended flight trajectory. Figure 11 shows the simulation result of the design of trapezoidal fins using the OpenRocket software. This software offers user-friendly customization and allows printing in a 1:1 scale, providing the freedom to export the design to a CNC router for cutting the fins to the dimensions provided by the simulator, including the number of fins, tilt, base line length, upper edge length, height, and angle of attack.

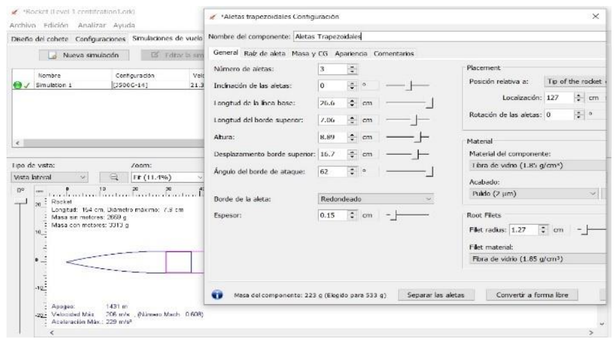

Figure 11 Simulation Result for Rocket Fins
Source: Own elaboration. OpenRocket

Once the fins design phase was completed, we initiated the manufacturing phase. The rocket fins were constructed using fiberglass with the lamination process technique. This involves overlaying consecutive layers of fiberglass cloth, applying a resin mixture between each layer until achieving a rectangle of the desired thickness. It is crucial during the resin application not to leave any bulges or air bubbles. Figure 12 illustrates the result of the lamination process and the cutting of the fins using the CNC router.

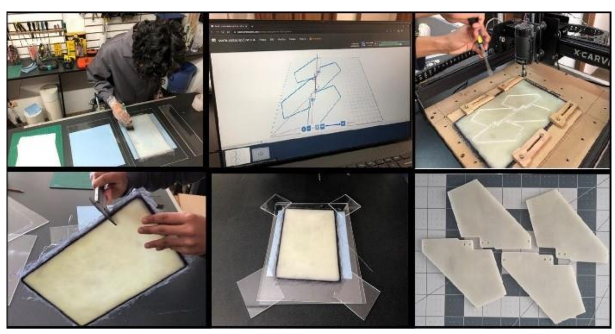

Figure 12 Fiberglass lamination process and cutting of the rocket fins
Source: Own elaboration.

Results

The use of simulators is a common practice in the aerospace industry today. The quick response obtained during the development phase of any project facilitates understanding of rocket behavior under various conditions, leading to safe and effective designs. This technique allows engineers to virtually test different configurations and parameters before conducting physical tests, helping to reduce costs and risks associated with rocket development. The software used to design the dimensions of the nose cone, fuselage, and fins is OpenRocket, as shown in Figure 10.

From the previous section, by using the simulator, we managed to optimize the weight and dimensions of the nose cone, fuselage, motor, and fins, thus achieving greater altitudes. The final result of the simulation yielded a height parameter of 1431 meters, with the dimensions of the nose cone being 30cm in length and 7.9 cm in diameter; for the fuselage, a circular tube of 124 cm in length, 8 cm in diameter, and 0.3 cm thick; and for the 3 trapezoidal fins, dimensions of 26.6 cm for the base line length, 7 cm for the upper edge length, 9 cm in height, and an angle of attack of 62 degrees.

In Figures 2, 4, and 11, the results of each measurement from the simulation for the nose cone, fuselage, and fins are shown. The simulation also provides important information such as its total length of 154cm and a diameter of 7.9 cm; total weight of 3313 grams; maximum speed of 206 m/s (740 km/h); and an acceleration of 229 m/s².

It is worth noting that the rocket was manufactured with the weight and dimensions provided by the simulation to compare the simulated data with the practical results. For the practical experiment, the rocket launch took place at the Tripoli Mexico launch site located in Laguna Salada in the municipality of Mexicali, Baja California. With this launch, the rocket obtained level 1 certification from the international certifications provided by the Tripoli Rocketry Association. During the launch, parameters were recorded by an altimeter carried on board in the fuselage section of the rocket. The result for the height parameter was 1422.4 meters, like the simulation carried out by the OpenRocket software.

Figure 12 shows the result of the values recorded by the flight computer through the altimeter.

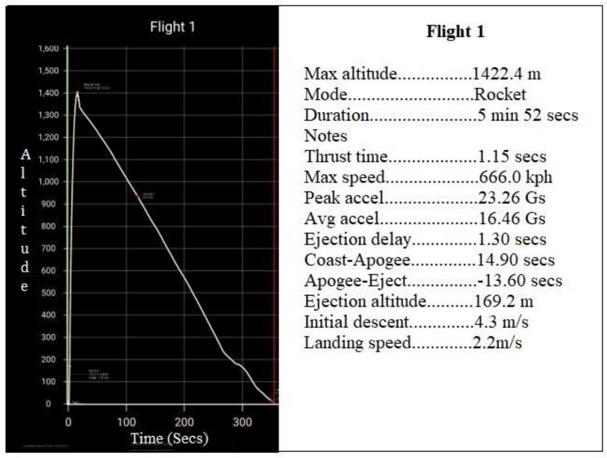

Figure 13 Altitude Parameters Resulted from Altimeter
Source: Own elaboration

Finally, the data obtained from the simulation is compared with the readings recorded by the altimeter during the rocket launch. From this comparison, it is observed that there is an approximate 1% error in the altitude parameter. The comparison of the other parameters is presented in Table 1.

Parameter	Simulated Data	Measured Data	Unit
Total length	154	154	cm
Total diameter	7.9	7.9	cm
Total weight	3313	3313	g
Max Speed	206 (740)	186 (666)	m/s (km/h)
Peak accel	229 (24.1)	227 (23.26)	m/s^2 (Gs)
Max altitude	1424	1422.4	m
Coast-Apogee	16.3	14.9	s
Thrust time	1.45	1.15	s
Duration of flight	212	352	s
Initial descent speed	6.44 (23.1)	4.3 (15.48)	m/s (km/h)
Landing speed	7.1 (25.5)	2.2 (7.92)	m/s (km/h)

Table 1 Simulated Parameters and Altitude Parameters Recorded by the Altimeter
Source: Own elaboration

Acknowledgements

Special thanks to the president of Tripoli Mexico for providing the facilities and conducting the rocket launches, as well as for the advice received during the development of this project.

Conclusions

In conclusion, the comparative analysis obtained for the rocket's altitude using the OpenRocket simulator and the on-board flight computer through an altimeter, valuable information regarding the accuracy and reliability of the proposed approach in this article could be provided. This indicates that the software possesses good predictive capability and can be relied upon for continued flight planning in the simulator with the suggested parameters. Additionally, adhering to the techniques recommended by the manufacturer for handling materials used in rocket manufacturing, such as fiberglass, is essential for ensuring safe and successful flights.

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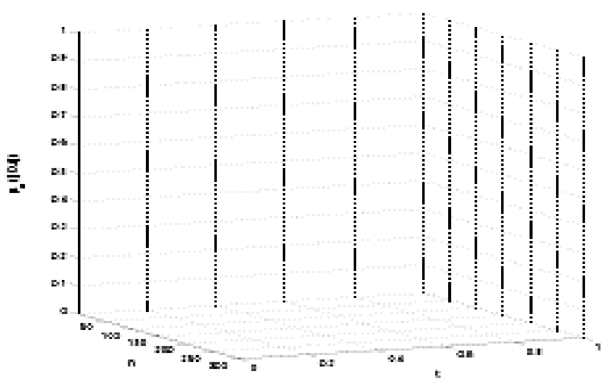

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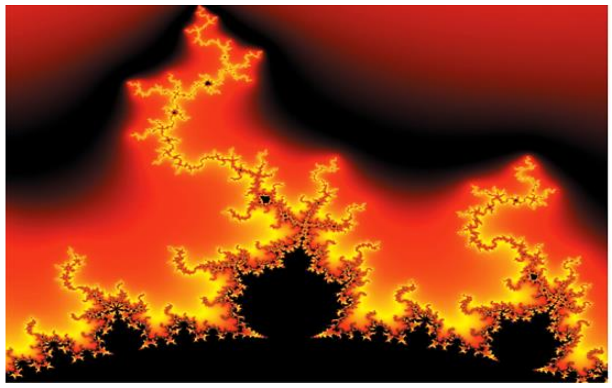

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