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DIRETORIA DE PESQUISA E PÓS-GRADUAÇÃO
PROGRAMA DE PÓS-GRADUAÇÃO EM TECNOLOGIA EM
ALIMENTOS

POTENCIAL TECNOLÓGICO E FUNCIONAL DE BARRAS NUTRITIVAS À BASE DE CASTANHA-DO-BRASIL E AMÊNDOAS DE BARU

Autora: Daniele Silva Lima
Orientadora: Katiuchia Pereira Takeuchi
Coorientadora: Dr[a]. Mariana Buranelo Egea
Coorientadora externa: Dr[a]. Raquel Aparecida Loss

Rio Verde - GO
Março - 2019

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Autora: Daniele Silva Lima
Orientadora: Katiuchia Pereira Takeuchi

TITULAÇÃO: Mestre em Tecnologia de Alimentos – Área de Concentração em Tecnologia e Processamento de Alimentos.

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BIOGRAFIA DA AUTORA

Daniele Silva Lima, filha de Sueli da Silva Lima e Joaninho de Lima, nasceu em 21 de outubro de 1992, na cidade de São José do Rio Claro, Mato Grosso.

Em março de 2010, ingressou no curso de Engenharia de Alimentos pela Universidade do Estado de Mato Grosso (UNEMAT) – Campus de Barra do Bugres – Mato Grosso. Foi bolsista de graduação sanduíche da CAPES na The University of Adelaide (SA), Austrália (2013-2014) e graduou-se em outubro de 2016.

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LISTA DE SÍMBOLOS, SIGLAS, ABREVIAÇÕES E UNIDADES

ATP - The Adenosine triphosphate

g- gramas

RDI- Reference daily intake

Aw- water activity

TTA- titratable acidity

pH- hydrogen potential

g- grams

mg-milligrams

µg- micrograms

mL- milliliters

cm- centimeters

mm- millimeters

mm s^{-1}- megameter per second

N- newton (unit of force)

J- joule (unit of energy)

RESUMO

LIMA, DANIELE SILVA. **Potencial Tecnológico e Funcional de barras nutritivas à base de castanha-do-Brasil e amêndoas de Baru**. 2019. Dissertação apresentada como parte das exigências para obtenção do título de mestre no Programa de Pós-Graduação – *Stricto sensu* em Tecnologia de Alimentos do Instituto Federal de Educação, Ciência e Tecnologia Goiano – Campus Rio Verde.

O consumo de amêndoas e nozes pode trazer benefícios para a saúde humana devido aos seus compostos bioativos. No Brasil, as amêndoas de Baru e castanhas-do-Brasil são largamente exploradas pelas comunidades através de cooperativas. No entanto, a maior parte da produção vem da atividade de extração, então essas castanhas e amêndoas oferecem oportunidades de renda para as comunidades ao redor do bioma onde elas são nativas. Desde então, a matéria-prima utilizada neste estudo veio de duas cooperativas diferentes, destacando a importância de incentivar uma forma de sustentabilidade para essas comunidades. Em seguida, com essa abordagem, objetivou-se realizar o desenvolvimento de barras de castanha-do-Brasil e baru amêndoas, e o produto permitirá a utilização de produtos que não se enquadram na classificação comercial, reduzindo desperdício e geração de resíduos e contaminação ambiental. Boas Práticas de Fabricação foram seguidas para produzir a barra com a adição de ingredientes saudáveis e visando preservar os compostos bioativos de sua matéria-prima após o processamento até o momento do consumo. Portanto, para avaliar o potencial das formulações foram realizadas análises físico-químicas, avaliação de compostos bioativos, textura instrumental e avaliação sensorial. Quanto à matéria-prima, as amêndoas de baru apresentaram maior teor de proteínas do que as castanhas-do- Brasil 24,95 e 14,74 g 100 g^{-1}, enquanto a castanha-do-Brasil apresentou maior concentração lipídica, alcançando 59,36 g 100 g^{-1}. Tanto a castanha-do-Brasil com casca marrom quanto a amêndoa de baru apresentaram valores semelhantes para compostos fenólicos totais; no entanto, a castanha-do-Brasil com película marrom apresentou mais compostos fenólicos totais do que sem a película. As formulações podem ser classificadas como alto conteúdo de minerais. Em relação à textura instrumental, o maior valor para firmeza foi 217,9 N (C0: B100), enquanto para adesividade esta a mesma amostra atingiu o menor valor -23,62 N. A textura é um parâmetro importante, pois na avaliação sensorial as principais razões de preferência e aceitação foram sabor, textura e cor. Em suma, C25:75 é a formulação mais adequada para ser produzida, pois apresentou bom balanço de conteúdo nutricional. Além disso, o C25: B75 obteve maior aceitação e preferência na avaliação sensorial.

Palavras-chaves: Compostos bioativos, alto teor de minerais, barras nutritivas

ABSTRACT

LIMA, DANIELE SILVA. **Technological and Functional Potential of Nutritious Bars based on Brazil Nuts and Baru Almonds.** 2019. Dissertation presented as part of the requirements to obtain a master's degree in the Postgraduate Program - *Stricto sensu* in Food Technology of the Goiano Federal Institute of Education, Science and Technology - Rio Verde Campus.

The almonds and nuts intake can bring benefits to human health due to their bio actives compounds. In Brazil, Baru almonds and nuts are largely explored by communities through cooperatives. Yet, mostly of the production come from extraction activity, then these nuts and almonds offer income opportunity for communities around the biome where they are native. Since, the raw material employed in this study came from two different cooperatives, they highlighted the importance to incentive a way of sustainability for those communities. Then, with this approach it was aimed the nutritious bars development made from Brazil nuts and baru almonds where the product will allow the use of products that did not fit the commercial classification, reducing waste and generation of residues and environmental contamination. Good Manufacturing Practices were followed to produce bars with the addition of healthy ingredients and aiming to preserve the bioactive compounds from their raw material after processing until the consumption. Therefore, to evaluate the formulations potential it was performed physical and chemical analyses, evaluation of bioactive compounds, instrumental texture and sensory evaluation. Regarding the raw material, baru almonds had higher protein content than Brazil nuts 24.95 and 14.74 g 100 g^{-1}, while Brazil nuts had more lipidic concentration reaching 59.36 g 100 g^{-1}. Both Brazil nuts with brown skin and Baru almonds had similar values for total phenolic compounds; however, Brazil nuts with brown skin showed more total phenolic compounds than without the skin. The formulations could be classified as high mineral content. Regarding to instrumental texture the highest value for firmness was 217.9 N (C0:B100), while for adhesiveness it reached the lowest value (-23.62 N). Texture is an important parameter as in the sensory evaluation the main reasons for preference and acceptance where flavor, texture and color. Therefore, C25:75 could be the most suitable formulation to be produced as it had a good nutritional content balance and C25:B75 obtained more acceptance and preference in the sensory evaluation.

Key-words: bioactive compounds, high mineral food, nuts snack bars

1. INTRODUÇÃO

Castanhas e amêndoas são apreciadas em todo o mundo com variedade de produtos, tais como ingredientes de receitas caseiras, pastas, lanches ou em sua forma natural adicionada de sal. O consumo de castanhas e amêndoas vem sendo associado a vários benefícios para a saúde, inclusive reduzindo o risco de doença cardiovascular (LI; BRENNAN; WEDICK et al. 2009).

Além do mais, castanhas e amêndoas no geral são reconhecidas por seu valor nutricional que têm grande potencial para promoção da saúde devido seus altos níveis de antioxidantes, ácidos graxos essenciais, vitaminas, aminoácidos e minerais. Assim, são conhecidos como compostos bioativos, pois possuem características funcionais quando incluídos na dieta (LI et al. 2009; COLPO; VILANOVA; REETZ AL. 2013).

As castanhas e amêndoas também possuem valores significativos de tocoferóis. Os tocoferóis são precursores da vitamina E a qual possui propriedades antioxidantes, que atuam na promoção da saúde evitando doenças como câncer, diabetes, cataratas, doenças cardiovasculares e cerebrovasculares; esta vitamina também está associada com a prevenção ou redução do declínio cognitivo (KANG; COOK; MANSON et al. 2006; CATANIA; BARROS; FERREIRA 2009). Estudos indicam que ocorre sinergia entre o selênio e a vitamina E, quando combinados na dieta, gerando sobrecarga de ações terapêuticas que protegem as organelas e as membranas dos danos causados pela oxidação (SCHOMBURG; KÖHRLE, 2008; YANG, 2009; COLPO, VILANOVA; REETZ et al. 2013).

No entanto, no processamento industrial de sementes oleaginosas, como a castanha-do-Brasil e amêndoa de baru são obtidos subproduto sem valor comercial, por causa de problemas na adequação para a classificação comercial, resultantes das quebras ou danos nas sementes, diminuindo a qualidade microbiológica e nutricional. Assim, a hipótese que motivou este estudo é que o desenvolvimento de uma barra nutritiva à base de castanhas-do-Brasil e amêndoas de Baru permitirá o aproveitamento desses produtos que não se adequaram para a classificação comercial. Além disso, diminuirá desperdícios, geração de resíduos e contaminação ambiental. O presente estudo busca o processamento das sementes oleaginosas seguindo as Boas Práticas de Fabricação, com adição de ingredientes saudáveis e com objetivo de manter os compostos bioativos de sua matéria-prima após processamento e, se possível, caracterizar o alimento como um *Smart food.*

A premissa de Smart Foods segundo o International Crops Research Institute for the SemiArid Tropics (2015) é que o alimento se origine de uma planta nativa, pois esta é resiliente a mudanças climáticas, tem diversos usos e potencial para desenvolvimento sustentável, produzindo um produto final saudável e com mínimo impacto ambiental. Desta forma, estudos que visam o desenvolvimento de produtos que agregam valor à matéria-prima motiva os produtores a manter o cultivo sustentável ao invés do extrativismo predatório das árvores que produzem os frutos e castanhas. Além disso, ao aplicar conhecimentos tecnológicos, é possível explorar as propriedades funcionais da matéria-prima, tornando o produto final uma alternativa com alto valor nutricional para os consumidores que buscam uma dieta mais saudável.

Segundo a RDC nº 272 de 22/09/2005 (BRASIL, 2005), o produto em desenvolvimento se enquadra em produtos vegetais, que define os produtos que são obtidos das partes comestíveis de vegetais as quais incluem sementes oleaginosas obtidas a partir de processos como desidratação, secagem, cocção, fermentação, extrusão, laminação dentre outros processos tecnológicos considerados adequados para a produção de alimentos seguros. Ainda, podem conter alguns aditivos desde que não descaracterize o produto.

Diante desse contexto, o desenvolvimento de alimentos de alto valor nutricional e com apelo funcional agrega valor à matéria-prima regional, garantindo ao consumidor e ao produtor um produto de qualidade, renda e sustentabilidade econômica. A proposta de estudo de desenvolvimento de uma barra nutritiva à base de castanha-do-Brasil e amêndoas de baru terá seus resultados transferidos a empreendimentos de economia solidária e com foco em processamento de produtos da sociobiodiversidade, buscando parcerias com cooperativas do estado de Goiás e tendo previamente, a parceria da Cooperativa Mista de Guariba-COMIGUA. A COMIGUA está estabelecida no distrito de Guariba, município de Colniza/MT e foi criada para permitir que a comunidade de pequenos agricultores e extrativistas pudesse produzir e comercializar produtos agroextrativistas de espécies nativas encontradas em grande quantidade na região noroeste de Mato Grosso. A COMIGUA possui grande interesse no desenvolvimento do projeto apresentado nesta proposta para uma imediata utilização e comercialização prioritariamente para o Programa Nacional de Alimentação Escolar (PNAE) e Programa de Abastecimento de Alimentos (PAA) da CONAB.

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OBJETIVOS

GERAL:

Desenvolver barras nutritivas com um mix à base de castanha-do-Brasil e amêndoa de baru, com características tecnológicas para ser um lanche rápido (*snack*), com alto valor agregado e características nutritivas e funcionais, que contribuam para a promoção da saúde.

ESPECÍFICOS

1) Caracterizar a matéria-prima por meio de análises físico-químicas;

2) Desenvolver formulações de barras nutritivas à base de castanha-do-Brasil e amêndoas de baru;

3) Caracterizar as formulações por meio de análises físico-químicas e tecnológicas;

4) Realizar análises microbiológicas das barras nutritivas;

5) Analisar sensorialmente a aceitação do produto, utilizando os testes de escala do ideal, intenção de compra e ordenação-preferência;

6) Determinação do conteúdo fenólico total, capacidade antioxidante e minerais.

CAPÍTULO 1:

TECHNOLOGICAL AND FUNCTIONAL POTENTIAL OF NUTRIOUS BARS BASED ON BRAZIL NUTS AND BARU ALMONDS

ABSTRACT

The almonds and nuts intake can bring benefits to human health due to their bio actives compounds. In Brazil, Baru almonds and nuts are largely explored by communities through cooperatives. Yet, mostly of the production come from extraction activity, then these nuts and almonds offer income opportunity for communities around the biome where they are native. Since, the raw material employed in this study came from two different cooperatives, they highlighted the importance to incentive a way of sustainability for those communities. Then, with this approach it was aimed the nutritious bars development made from Brazil nuts and baru almonds where the product will allow the use of products that did not fit the commercial classification, reducing waste and generation of residues and environmental contamination. Good Manufacturing Practices were followed to produce bars with the addition of healthy ingredients and aiming to preserve the bioactive compounds from their raw material after processing until the consumption. Therefore, to evaluate the formulations potential it was performed physical and chemical analyses, evaluation of bioactive compounds, instrumental texture and sensory evaluation. Regarding the raw material, baru almonds had higher protein content than Brazil nuts 24.95 and 14.74 g 100 g^{-1}, while Brazil nuts had more lipidic concentration reaching 59.36 g 100 g^{-1}. Both Brazil nuts with brown skin and Baru almonds had similar values for total phenolic compounds; however, Brazil nuts with brown skin showed more total phenolic compounds than without the skin. The formulations could be classified as high mineral content. Regarding to instrumental texture the highest value for firmness was 217.9 N (C0:B100), while for adhesiveness it reached the lowest value (-23.62 N). Texture is an important parameter as in the sensory evaluation the main reasons for preference and acceptance where flavor, texture and color. Therefore, C25:75 could be the most suitable formulation to be produced as it had a good nutritional content balance, and C25:B75 obtained more acceptance and preference in the sensory evaluation.

Key-words: active compounds, high mineral food, nuts snack bars

1. INTRODUCTION

Nuts and almonds are generally recognized for their nutritional value which has great potential for health promotion due to their high levels of antioxidants, essential fatty acids, vitamins, amino acids and essential minerals. These compounds are known as bioactive compounds and they have functional characteristics when included in diet (Colpo, Vilanova, Reetz et al., 2013). Some of the benefits that has shown association by eating nuts and almonds include pressure control, anti-inflammatory action, cholesterol reduction, among others (King et al. 2008).

Brazil nuts and baru almonds can have a variety of minerals content, the minerals intake in the correct amount promotes a good functioning of human metabolism and provides the feeling of well-being. Calcium, for example, is primordial for muscles and nerves excitability and acts by activating various reactions such as oxidation of fatty acids and transport of ATP together with magnesium. Iron is necessary for formation and function of red blood cells and is essential in the ATP synthesis; facilitates the electrons transfer in the respiratory chain, and also participates in the oxygen transport, transporting and storing oxygen in the muscle and releasing it when necessary during muscle contraction. Among other functions, magnesium, manganese, zinc and selenium have a special emphasis on their regulatory and enzymatic functions, since several enzymatic reactions act as cofactors, particularly those involving metabolism of food components, being essential for energy metabolism (Huskisson, Maggini, Ruf, 2007).

The market sources of baru almonds and Brazil nuts in Brazil, comes from extraction activity, so alongside of their health benefits, they offer income opportunity for some communities which forms cooperatives to process and sell these native products. As the raw material employed in this study came from two different cooperatives, it became clear the importance to incentive a sustainability way for those communities. One step can be changing technological process such as developing products that adds more value to the raw material, reducing stocks.

In oilseeds industrial processing, especially Brazil nuts and baru almonds, there are products that do not obtain high commercial value, due to problems of suitability to commercial classification, usually due to breaks or damage to the seeds, which decreases microbiological and nutritional quality. Then, it was aimed the nut bar development made from Brazil nuts and baru almonds. The bars will allow the use of products that did not fit the commercial classification, reduce waste and generation of residues and environmental contamination. The nut bars processing was performed following the Good Manufacturing Practices, with the addition of healthy ingredients and with the objective to preserve the bioactive compounds from their raw material after processing until the consumption and, if possible, characterize the food as a smart food. Basically, this classification premise is that the food originates from a native plant because it is resilient to climate change, has several uses and potential for sustainable development, producing a healthy final product and with minimal environmental impact (International Crops Research Institute for the Semi-Arid Tropics, 2015). Hence, to evaluate the formulations potential it was performed physical and chemical analyses, evaluation of bioactive compounds, instrumental texture and sensory evaluation.

2. MATERIAL AND METHODS

2.1. Acquisition and preparation of the raw material

Brazil nuts were supplied by the COMIGUA cooperative, which is a partner of this project and is located in the district of Guariba, municipality of Colniza/MT. The almonds of baru come from a cooperative located in Pirenópolis/GO.

Baru almond contain a trypsin inhibitor being necessary a heat treatment to be edible for human consumption (Botezelli, Davide & Malavasi, 2000). Then the baru almonds were roasted in a conventional oven at 200°C for 20 minutes because this temperature worked out better to maintain the almonds sensorial quality. After the nuts and almonds were cracked and roasted, they were kept separately in polyethylene plastic bags and storage at room temperature about 25°C, until the nut bars production.

2.2 Nutritious bars production

Formulations were tested previously with different concentrations of nuts, almonds and other ingredients, the proportions which suited better the taste and texture aspects were defined and produced as shown in table 1. Where the proportions of the mean ingredients are shown as C0:B100 (100% Baru almonds), B0:C100 (100% Brazilian nuts) and the other proportions respectively followed by the letters B for baru almonds and C for Brazil Nuts.

Table 1. Ingredients and formulations to obtain the nut bars.

Ingredients	**Formulations**				
	C0:B100	**C25:B75**	**C50:B50**	**C75:B25**	**C100:B0**
Baru Almonds (g)	87	66.5	44.06	22.3	0
Brazil Nuts (g)	0	22.2	44.08	66	87.3
Sunflower Lecithin (g)	2	2	2	2	2
Brazil Nuts oil (g)	3	3	3	3	3
Honey (g)	9.1	9.2	9.1	9.3	9.2
Total (g)	101.1	102.9	102.2	102.6	101.5

Baru almond (B), Brazil Nuts (C).

In order to obtain the nut bars, the baru almonds were roasted and peeled and Brazil nuts were cracked, the process is shown in the figure 1. After the previous nuts and almonds preparation, they were gridded together for about 15 min according to its respective proportions. During the gridding process Brazil nuts oil was added followed by lecithin and honey. After that the final product was transferred to stray to be laminated and pressed at a pressure of approximately 4.32 Pa then it was packed in a plastic film and rest in the refrigerator for 8 hours, so it reached a firmer texture and made the cutting process more precise.

The cooperative which brought the Brazil nuts for this study reported that its products have 14 µg g^{-1} of selenium content. Due to the Brazil nuts selenium content the bars were cut in cubes of an average of 3 g in order that the 100% Brazil nuts concentration do not exceed the diary limit of selenium consumption which is an average of 55 µg a day for men and women aged from 19 to 70 (IOM, 2000). Finally, the cubes were packed individually in zip polyethylene plastic bags and stored at room temperature for further analyses. It´s important show information about selenium consumption to consumers in the package about Nutritional Information, so “Only one nutritious bar is sufficient to reach RDI for selenium. Please, don’t eat more than 10 bars per day because higher doses of selenium cause toxicity”.

The yield was calculated in terms of income and outcome and expressed as percentage.

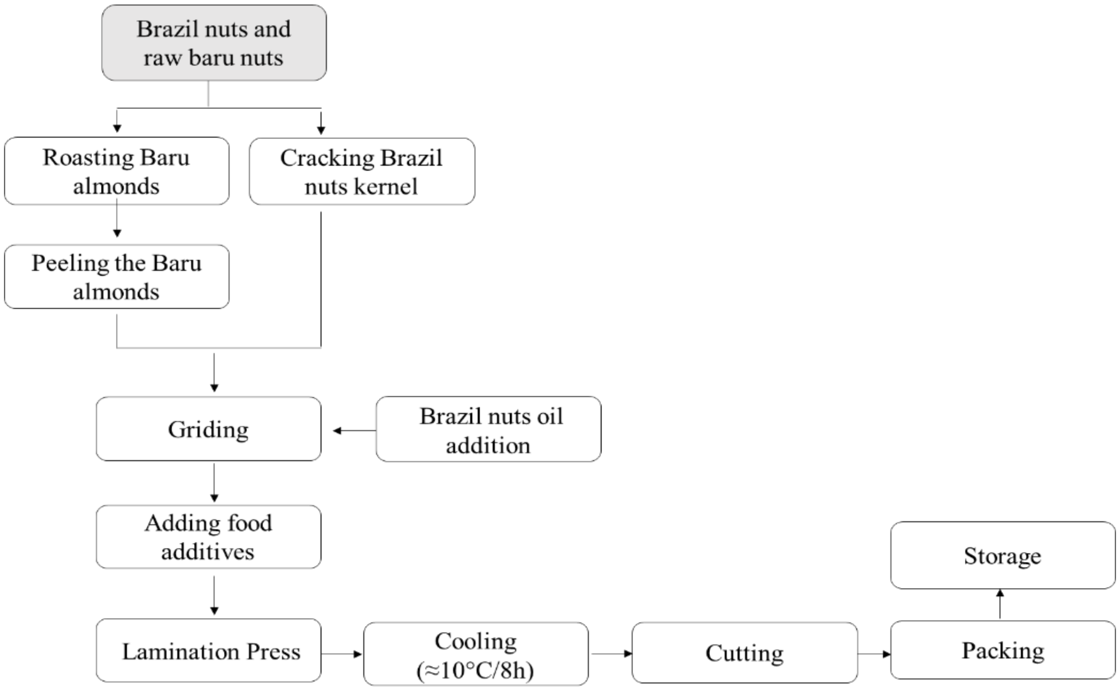


Figure 1. Flowchart of nut bars obtained from Brazil nuts and Baru almonds

2.3. Proximal composition and microbiological analysis

Moisture, protein and ash were performed as described by AOAC (2005). The moisture content was determined by gravimetry at 105ºC (method 925.40) protein (method 950.48), ash (method 940.49). The Bligh Dyer method (BLIGH & DYER, 1959) was performed to determine the total lipids. The water activity content (aw) was measured by a HygroPalm at a room temperature around 26 to 27 °C. To measure the pH values it was employed a digital pH meter. The total titratable acidity (TTA) was performed by titration with 0.1 M NaOH and is expressed as percentage.

The microbiological analysis was carried out, according to the food standards item 4 °C from RDC n°12 (BRAZIL, 2001). Then absence of *Salmonella ssp* was verified by the method VIDAS® AOAC 2011.03 and Coliforms at 45 °C by AFNOR Validation 3M 01/02-09/89C. After that the sensory analyses could be performed.

2.4. Total phenolic compounds, antioxidant activity and mineral content

The phenolic extracts for total phenolic compounds and antioxidant activity were prepared with acetone adapted from John and Shahidi (2010) and under absence of light. For 1 g of the sample it was added 20 mL of acetone, then put in ultrasonic bath (Sony Clean 2, Sanders of Brazil, Santa Rita do Sapucai -MG –Brazil) for 25 min, after that the samples were filtered in and the process was repeated for solids remained in the filter. Finally, the extracts were placed in a 50 mL volumetric balloon and completed with distilled water.

To determine the total phenolic compounds, it was followed the Folin-Ciocalteu method of colorimetry (SINGLETON; ROSSI, 1996). The antioxidant capacity was measured by the $ABTS^+$ (2,2'-azinobis 3-ethylbenzthiazoline-6-sulfonate acid) method in comparison to the standard Trolox® compound (RE et al., 1999; KUSKOSKI et al. 2005) and also by the free radical sequestration analysis with 1,1-diphenyl-2-picrylhydrazyl reagent (DPPH) (RUFINO, et al., 2007).

Minerals were determined by Spectroscopy of Atomic Force (Topometrix, Discoverer, TMX 2010, Santa Clara - CA – USA) as described by Leite, Zeimath, Herrmann (2005). The results were obtained with an atomic force microscopy

2.5 Instrumental color

A Croma Meter CR-400 (Konica Minolta, Osaka, Japan) was used to measure the parameters L*, a*, b*, Chroma (C*) and Hue (°h) in accordance with CIE (*Commission Internationale de I'Eclairage*). The Croma meter acquired calibration with standard white plate, which calibration parameters where L*(93.798), a*(4.528), b*(-1.561), C*(4,790) and °h (340,97). Since it was a portable colorimeter, it was placed above the samples with white background. The samples were homogenized and placed on a petri plate and the readings were carry out in triplicate with seven repetitions for each formulation.

2.6 Instrumental texture

Cubic bars (approximately 1.5 x 1.5 x 1.2 cm) based on Brazil nut and(or) baru almond for instrumental texture evaluation were removed from incubated storage (7±1 °C) and analyzed after 2 hours, at temperature 25 °C.

The rheological properties were performed in a texturometer (TA Instruments, TA-XT Plus, Texture Analyzer Stable Microsystems, Surrey, England) using normal compression with 500 N load cell, while force (N) versus time (s) data were recorded (Banach and others 2014). The texturometer was calibrated with a standard mass 500 g. The trigger force was set as 0.05 N for all tests.

For force application on bars based on nuts and almonds, it was analyzed in two modes: 1) under shear or cut using the geometry HDP/WBV (Warner Bratzler Blade Set with 'V' slot blade for USDA Standard) and 2) normal force compression using an aluminum cylindric geometry P/36R of 36 mm diameter.

The shear mode test was performed to verify the ability to cut small bars sample (n=5), commonly in human mastication process. Tests parameters for shearing bars were: cross head speed for pre-test, during test and post-test was 1 mm s^{-1}, target mode was strain of 130 % in relation to initial sample height to ensure a complete bar cutting into two pieces.

The sample integrity was analyzed by application compression force (n=5) under flat plate (P/36r) using pre-test, test and post-tests speeds of 1 mm s^{-1} for all tests, target mode was strain of 70 % in relation to initial sample height to ensure a wide compression, simulating human mastication process in the molar teeth.

Firmness is the peak force or maximum force (N) that occurs during compression (Piga et al., 2005) under normal force. During shear test, the maximum peak is the shear force (N) used to report bar hardness. Adhesiveness (J) was taken as the absolute area under the force versus time curve during probe withdrawal after the first compression. Cohesiveness (%) was the ratio of area under the second compression curve to the area under first compression curve (Kaur, Ahluwalia, Sachdev & Kaur, 2018).

2.6. Sensory evaluation

In order to evaluate the samples by their sensorial aspects a panel of 100 untrained people were recruited within the university, the accessors willingly accepted to take all the proposed affective tests. Then, it was applied the acceptance test to the sensory attributes of taste, odor, color, texture and overall appearance; the just about right scale for attributes of color and texture; purchasing intent and preference ordering as described by Dutcosky (2011) and Kemp, Hollowood e Hort (2009).

For the acceptance test it was applied a 9cm non-structured hedonic scale being zero "Dislike Extremely" and nine "Like Extremely". The final score was distributed in terms of "rejection" (0 < score < 4.99), “indifference” (4.00 < score < 5.99) and “acceptance” (6 < score < 9). The acceptability index was calculated by the average score assigned to product x 100 / maximum score assigned to product and expressed as a percentage (%). It was also calculated the consensor index proposed by Silva et al. (2010).

To access just about right test the judges could give scores from +4 to -4 (+4 = extremely more than ideal; 0= just about right; -4= extremely less than ideal). The purchasing intent was scored from 5 to 1, where 5 meant definitely would by and 1definitely would not buy. While the preference ordering was assigned from the most preferred to the lest from the right to the left and its statistical analysis was performed by the Friedmann test, with Newell and Mcfarlane tables (p<0.05) (ABNT 1994). The project was approved by the Standing Committee on Ethical Research with Human Beings, at the Goiano Federal Institute of Education, Science and Technology (CAAE no.: 97753818.8.0000.0036/2018).

2.7. Statistical analysis

The formulations physical, microbiological and chemical analyzes were performed in duplicate and at least three replicates of each analysis (n≥6). The mean values from these analyzes and the sensory attributes of the different products were submitted to analysis of variance (ANOVA) using the software Sisvar (Ferreira, 1998). For a multiple comparison between the means the Tukey test was applied at a significance (p<0,05). For ordering preference, the Friedmann test, with Newell and Mcfarlane tables (p<0.05) was applied.

3. RESULTS AND DISCUSSIONS

3.1 Nutritious bars production

The formulations yield was determined by the quantity of ingredients income and final product outcome expressed as yield percentage in table 2. All the formulations had more than 95% yield and lost material is mostly related to product stock in the grinding cup and blades.

Table 2.Nut bars formulations yield

Formulations	C0:B100	C25:B75	C50:B50	C75:B25	C100:B0
Income (g)	101.1	102.9	102.24	102.6	101.5
Outcome (g)	97	101.2	99.54	99.52	98.31
Yield (%)	95.94	98.35	97.36	97.00	96.86

3.2 Proximal composition and Instrumental color

The raw nuts and almonds were evaluated as the bar composition depends on the raw material conditions. As shown in table 3 the moisture content did not differ between the five bars formulations. Since, Brazil nuts and baru almonds have similar moisture content the raw ingredients were stored at same conditions, moisture content did not significantly vary. In products known as ready to eat low moisture content is important for quality and storage period without the use of preservatives. Therefore, according to Parvalli et al (2015) the stability of cereal, nuts and sneak bars in general is greatly related to low moisture content and water activity. The main fungi that produces aflatoxins in nuts is *Aspergillus flavus* and the optimal aw content for its grow ranges around 0.82 to 0.99 (Pitt and Hocking 2009). Furthermore, the water activity content in the raw ingredients was around 0.44 and 0.63 for baru almonds and Brazil nuts, respectively, so it was within the current legislation (Brazil, 1976), that regulates values of 11 to 15% of aw in Brazil nuts. The water activity between C25:B75 and C75:B25 did not significantly differ and C100:B0 had the higher aw content due to its formulation is based on 100% of Brazil nuts and these nuts had higher aw content compared to baru almonds. As the other ingredients were fixed for all formulations the variation is closely related to the raw nuts aw content.

Protein content found for baru by Souza et al. (2011) was 29.92 g 100 g^{-1}, while in this study it was lower, about 24.95 g 100 g^{-1}. According to Carlos et al. (2017), nuts and almonds from different locations can present variations in their chemical and nutritional composition, it is characteristic from non-domestic plants as Brazilian Cerrado or Brazilian savanna fruits such as baru. The United States Department of Agriculture - USDA (2006), reports that Brazil nuts contains 14.5 g 100 g^{-1} protein content, the samples used for the formulations matched the USDA report. For protein concentration, formulations C0:B100, C25:B75 and C50:B50 did not significantly differ and reached more quantity of protein per 100 g. While, C50:B50 and C75:B25 were similar at 5% confidence level and C100:B0 was the bar with least protein content. To sum up, the formulations with more baru proportion presented more proteins in g 100 g^{-1}, since the baru has a protein content superior to Brazil nuts.

The lipid content in baru almonds found in this study were higher than the one verified by Takemoto et al. (2001) which was (32.2 g 100 g^{-1}) and Vera et al. (2009) (33.28 g 100 g^{-1}). Nonetheless, it was closer to the content found by Souza et al. (2011) (41.95 g 100 g^{-1}). According Naves and Freitas (2010) Brazil nuts can reach values of 64.94 % of lipids content, so it can be higher than the values noticed in this study. Brazil nuts lipids content is higher than Baru nuts and it was verified that the lipids concentration increased in the formulations as the Brazil nuts content was higher, as a result C0:B100 and C100:B0 had the lowest and highest lipids content, respectively.

Regarding the ash content there was no significant difference at 5% level among C0:B100, C25:B75, C50:B50 and C75:B25, while C100:B0 did not differ from C25:B75 but from the others. The values found from 3.74 to 3.75 g 100 g^{-1} indicate an expressive minerals quantity. The ash baru content in this study was 3.10 g 100 g^{-1} lower than the one found by Souza et al. (2011) (3.18 g 100 g^{-1}). In food analysis, pH and titratable acidity are concepts interrelated. One is an important mean to estimate the of a microorganism ability to growth in a particular food, the other works as a predictor of the way that organic acids can impact the food flavor (Tyl & Sadler, 2017). The optimal pH value for nuts in general is around neutral, as it is shown in table 3, the pH values for the nuts, almonds and formulations were close to neutral, which means it is good for food conservation, and also the TTA percentages were low, formulations F4 and F5 did not differ, however; they differed from the others, being F1 the sample with higher TTA value.

Table 3. Proximal composition and instrumental color of the raw material and five nut bars formulations

Analysis	Baru	Brazil Nuts	Formulations				
			C0:B100	C25:B75	C50:B50	C75:B25	C100:B0
Moisture (g 100 g^{-1})	2.07 ± 0.03 (1.65)	2.26 ± 0.13 (5.8)	1.19^{a} ± 0.09 (7.17)	1.17^{a} ± 0.05 (4.24)	1.17^{a} ± 0.04 (3.77)	1.16^{a} ± 0.05 (4.70)	1.12^{a} ± 0.03 (3.30)
Water activity (-)	0.437±0.00 (0.32)	0.630±0.001 (0.11)	0.508^{d}±0.003(0.56)	0.623^{b}± 0.004 (0.57)	0.599^{c}±0.003 (0.47)	0.617^{b}±0.001 (0.23)	0.684^{a}±0.001 (0.01)
Protein (g 100 g^{-1})	24.95 ± 0.68 (2.71)	14.74 ± 0.70 (4.75)	24.27^{a} ± 2.01 (8.3)	24.13^{a} ± 1.65 (6.9)	22.01^{ab}± 1.36 (6.2)	19.70^{bc} ± 0.61 (3.1)	17.92^{c} ± 0.39 (2.2)
Lipid (g 100 g^{-1})	41.69 ± 1.21 (2.89)	59.36 ± 0.23 (0.38)	42.1^{e} ± 1.33 (3.17)	44.81^{d} ± 0,38 (1.38)	50.72^{c} ± 1,16 (2.29)	54.77^{b} ± 0.90 (1.64)	61.03^{a} ± 1.38 (2.26)
Ash (g 100 g^{-1})	3.10 ± 0.17(5.32)	3.07±0.15 (4.78)	3.74^{a} ± 0.21 (5.7)	3.71^{ab} ± 0.11 (3.08)	3.75^{a} ± 0.14 (3.84)	3.73^{a} ± 0.19 (5.32)	3.43^{b} ± 0.19 (5.6)
pH (-)	6.24 ± 0.02 (0.33)	6.48 ± 0,01 (0.15)	6.31^{d} ± 0.01 (0.22)	6.36^{c} ± 0.02 (0.31)	6.46^{ab} ± 0.03 (0.47)	6.49^{a} ± 0.02 (0.37)	6.45^{b} ± 0.03 (0.46)
(TTA) (%)	1.11 ± 0.02 (1.49)	0.61 ± 0.01(1.36)	1.2^{a} ± 0.03 (2.6)	1.1^{b} ± 0.03 (2.5)	0.89^{c} ± 0.06 (6.7)	0.76^{d} ± 0.04 (5.2)	0.81^{d} ± 0.07 (8.8)
Color							
L*	36.59±0.97 (2.65)	44.23±1.66 (3.75)	32.32^{d}±1.40 (4.34)	40.24^{c}±0.66 (1.64)	40.65^{c}±0.11 (0.27)	46.47^{b}±0.78 (1.67)	49.48^{a}±1.45 (2.94)
a*	3.19±0.25 (7.84)	0.45±0.49 (1.09)	12.80^{ab}±0.57(4.48)	13.76^{a}±0.17 (1.24)	13.26^{a}±0.57 (4.28)	10.77^{b}±0.40 (3.70)	5.64^{c}±0.49 (8.66)
b*	11.99±0.57 (4.75)	7.67±1.26 (16.4)	18.44^{b}±1.40 (7.56)	22.93^{a}±0.87 (3.77)	25.74^{a}±1.91 (7.42)	23.96^{a}±0.60 (2.51)	16.33^{c}±0.99 (6.07)
C*	12.41±0.59 (4.75)	7.69±1.29 (16.7)	22.65^{b}±1.81 (8.0)	26.70^{a}±0.70 (2.62)	29.02^{a}±1.96 (6.75)	26.3^{a} ±0.53 (2.01)	17.26^{c}±1.10 (6.37)
°h	75.09±0.88 (1.17)	86.97±2.69 (3.09)	55.30^{d} ±1.80 (3.26)	59.19^{c}±1.12 (1.89)	63.00^{b}±1.31 (2.08)	65.77^{b}±1.00 (1.52)	71.26^{a}±0.46 (0.64)

() coefficient of variation value; low case letter in the same line did not differ at ($p<0.05$) significance level from Tukey test

In figure 2(A) and (B) the instrumental and real color are demonstrated, then it is possible to note a difference between them. However, instrumental color serves as parameter to generates colors in specific software to keep the quality standards in the daily production in an industry. Therefore, color is an important aspect for food acceptance as in the sensorial analyses this color aspect was mentioned as reason from preference

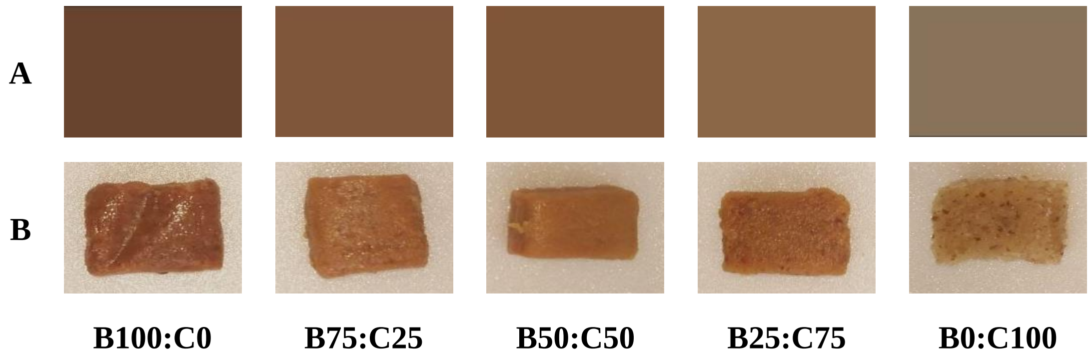


Figure 2. Demonstration of the instrumental color (A) and real color (B).

3.3 Lipidic profile, total phenolic compounds, antioxidant activity and mineral content

3.3.2. Total phenolic compounds and antioxidant potential

In fruits and seeds the phenolic compounds are related to their protective system against biotic and abiotic factors, that may explain the high contend in bioactive compounds in vegetables and its products (Simões et al. 2007).

The total phenolic content in fruits and nuts is widely estimate by the Folin-Ciocalteu reaction. In this study there was evaluated the total phenolic content in Brazil nuts with and without brown skin, baru almonds, roasted peeled baru almonds and the 5 nut bars formulations. Table 5 shows that Brazil nuts with brown skin had higher values than the nuts without brown skin. It is important to highlight these results so the manufactures take the brown skin off as less as they can to maintain more phenolic content in the nuts.

In general, the total phenolic content ranges from 103 to 1650 (mg GAE 100 g^{-1}) in nuts (Bolling, Mckay & Blumberg, 2010). Baru nuts reported to have contents similar to Brazil nuts with brown skin showing 1171.95 mgGAE.100 g^{-1} and 1179.69 mgGAE.100 g^{-1} respectively (acetone extract). This content was higher than reported by Lemos et al. (2012) that was 111.3± 1.8 mg GAE 100 g^{-1} (methanolic extract) for roasted peeled baru almonds.

The formulations were elaborated employing the nuts with brown skin, however; some nuts had more brown skin on them then others, then it may have affected the total phenolic content in the formulations. Among the formulations all of them differed from each other from a 5% of confidence level. The maximum value reached was for C75:B25 (943.13 mg GAE 100 g^{-1}) and the minimum for C25:B75 (828.13 mg GAE 100 g^{-1}).

The antioxidant potential has been associated to the reduction of free superoxide radicals production and xanthine oxidase inhibition. These properties confer to nuts the ability to reduce the free radicals production, and thus in the prevention of numerous chronic degenerative diseases (Agebratt et al., 2016 & Amarowicz, Pegg, 2017).

The results in table 5 were expressed in µM Trolox g^{-1} for both ABTS and DPPH analysis. In this study it was used acetonic extract as John and Shahidi (2010), which reported in their study that acetone worked better to extract phenolic compounds in Brazil nuts when compared to other extracts. Then in this study the content found for ABTS and DPPH method for roasted baru were 185.64 µM Trolox g^{-1} and 100.08 respectively. While Santiago et.al (2006) performed the analysis with ethanolic extracts and found the following values for the same methods 77 µM Trolox g^{-1} and 76 µM Trolox g^{-1}. With regards to Brazil nuts Miraliakbari and Shahidi (2008) verified for Brazil nut oil that extraction with hexane obtained value of 81.8 µM Trolox g^{-1} for ABTS Whereas Chloroform–methanol extraction presented a higher value 1216.9 µM Trolox g^{-1}. Then the values in table 5 found for Brazil nuts with acetonic extract is between the founded by another authors.

For ABTS samples C100:B0, C25:B75, C50:B50, C100:B0 did not significantly differ from each other and C75:B25 differed from C50B50. For DPPH none of the formulations differed from each other. Furthermore, it was not verified a correlation between total phenolic content and antioxidant activity among the bars by Pearson correlation evaluation.

Table 4.Antioxidant activity and total phenolic compounds in Brazil nuts, baru almonds and nut bar formulations

		ABTS (µM Trolox g^{-1})	**DPPH** (µM Trolox g^{-1})	**Total phenolics** (mg GAE 100 g^{-1})
Brazil nut	with brown skin	207.86*±1.27	96.47*±0.48	1179.69*±6.90
	without skin	182.86*±2.10	93.139*±0.96	519.03*±17.54
Baru	without skin	185.64±3.37	100.08±1.44	1171.95±20.30
Formulations	C100:B0	177.86^{ab}±1.27	111.47^{a}±4.28	876^{c}±7.69
	C25:B75	177.03^{ab}±2.68	103.42^{a}±5.46	828^{d}±5.92
	C50B50	176.19^{b}±0.48	106.49^{a}±2.68	906.29^{b}±7.08
	C75:B25	180.64^{a}±1.27	109.53^{a}±8.09	943.13^{a}±7.67
	C100:B0	179.25^{ab}±1.67	98.97^{a}±1.73	591.87^{e}±5.20

Low case letter in the same column did not differ at a ($p<0.05$) significance level from Tukey test. (*) indicates significant difference between Brazil nuts with and without brown skin ($p<0.05$) T- test.

3.2.3 Mineral contents

The intake of minerals is of high importance to healthy diet, since they work as precursors of well-being sense and metabolism well-functioning. Among the micronutrients, iron was the most abundant in the samples. It plays an important role in the function of red blood cells transporting oxygen in the muscles. The iron daily intake varies from 10 to 15 mg/day for adults (Rodushkin et al., 2011). Souza et al. (2011) found the following values for the elements in baru almonds Fe (35.7 µg g^{-1}), K (9803.57 µg g^{-1}), Ca (1109.4 µg g^{-1}), Mg (1643.1 µg g^{-1}) and P (8328 µg g^{-1}). Although it was not reported any value for Zn content in this study baru almond reached 22.65 µg g^{-1}, yet the Fe, Ca, Mg content were higher (95.35 µg g^{-1}), (6380 µg g^{-1}) and (2155 µg g^{-1}) respectively.

Suliburska and Kreipcio (2011) studied the bioaccessibility of iron, zinc, calcium and magnesium in seeds and nuts and reported an average of Fe (22 µg g^{-1}), Zn (24 µg g^{-1}), Ca (1703 µg g^{-1}) and Mg (2212 µg g^{-1}) for Brazil nuts. While Moodley, Kindeness and Jonnalagadda (2007) found the averages of Fe (132.5 µg g^{-1}), Zn (110.31 µg g^{-1}) Ca (7432.8 µg g^{-1}) Mg (9678.5 µg g^{-1}) and Se (36,1 µg g^{-1}). While, as table 6 shows, the averages in this investigation were Fe (95.35 µg g^{-1}), Zn (19.95 µg g^{-1}), Ca (6220 µg g^{-1}) and Mg (3270 µg g^{-1}). Regarding the selenium content the cooperative where the nuts came from reported that in that region the Brazil nuts reach 14 µg g^{-1}. It's important to know the raw nuts selenium content before designing the products as the selenium overdose of selenium can cause risk to human health.

Furthermore, the minimum values of Recommended Daily Intake (RDI) second Brazil (2005) for the macronutrients P, K, Ca, Mg are 105 mg day^{-1}, 705 mg day^{-1},180 mg day^{-1} and 63 mg day^{-1}, respectively. While for Fe, Mn, Cu and Zn the minimum daily intake is 2700 µg day^{-1}, 350 µg day^{-1}, 135 µg day^{-1} and 1650 µg day^{-1}, respectively.

In table 6, it is shown the percentage which a 3 g nutritious bar can supply of these minerals. Where, magnesium seemed to be more abundant supplying from 10.26 to 15.57% of the RDI as the quantity of Brazil nuts increased in the formulations. Iron which is an important micronutrient ranged from 10.59 to 14.71% of the minimum necessities a day. However, Brazil (2012) through the 54^{th} RDC of November 12th, indicate that a food can be considered source of mineral if it contains at least 15% of the RDI represented in 100 g and also a minimum of 30% of the RDI to be called as high mineral contents. Thus, the nutritious bars in this study could be considered as high mineral content nutritious bar, for instance, a 10 portion of C50:B50 could offer 37% P, 11% K, 35% Ca, 43% Mg, 42,17% Fe, 38% Mn, 81% Cu and 13% Zn of RDI.

Table 5. Baru almonds and Brazil nuts minerals content.

Minerals	**Baru almond**	**Brazil nuts**	**C0:100**	**% RDI (3 g bar)**	**C25:B75**	**% RDI (3 g bar)**	**C50:B50**	**% RDI (3 g bar)**	**C75:B25**	**% RDI (3 g bar)**	**C100:B0**	**% RDI (3 g bar)**
P (mg g^{-1})	3.31	4.58	3.31	**9.44**	3.62	**10.35**	3.94	**11.26**	4.26	**12.18**	4.58	**13.09**
K (mg g^{-1})	9.43	6.08	9.43	**4.01**	8.59	**3.65**	7.75	**3.30**	6.91	**2.94**	6.075	**2.59**
Ca (mg g^{-1})	6.38	6.22	6.38	**10.63**	6.34	**10.57**	6.30	**10.50**	6.26	**10.43**	6.22	**10.37**
Mg (mg g^{-1})	2.16	3.27	2.16	**10.26**	2.43	**11.59**	2.71	**12,92**	2.99	**14.24**	3.27	**15.57**
S-SO_4 (mg g^{-1})	3.19	2.86	3.20	-	3.11	-	3,03	-	2.94	-	2.86	-
Fe (µg g^{-1})	95.35	132.50	95.35	**10.59**	104.60	**11.62**	113.85	**12.65**	123.10	**13.68**	132.35	**14.71**
Mn (µg g^{-1})	20.05	6.60	20.05	**17.19**	16.69	**14.30**	13.33	**11.42**	9.96	**8.54**	6.6	**5.66**
Cu (µg g^{-1})	9.60	12.30	9.60	**21.33**	10.28	**22.83**	10.95	**24.33**	11.63	**25.83**	12.3	**27.33**
Zn (µg g^{-1})	22.65	19.95	22.65	**4.12**	21.98	**4.00**	21.30	**3.87**	20.63	**3.75**	19.95	**3.63**
B (µg g^{-1})	21.35	21.35	21.35	-	21.35	-	21.35	-	21.35	-	21.35	-

*The mineral contents for the bars are based on an average of the nuts and almonds concentration.

** The RDI refers to the % which a 3g bar can daily supply for a minimum consumption from adults > 18 years old (Brazil, 2018).

3.4 Instrumental Texture

Texture is one of the most important parameters connected to product quality. It is defined as the sensory manifestation of the food structure and the manner in which that structure reacts to the applied force (Meullenet et al., 1997; (Bchir, Jean-François, Rabetafika, & Blecker, 2018).

The cut (shear) test is expected to relate to the force required for tooth penetration into a food, particularly the incisors (i.e., planar penetration). In shearing tests, the probe penetrates into the test sample and the force necessary to achieve a certain penetration depth is measured. Both compressive and shear forces are involved in this test. The area behind the curve can be associated with the shearing work and thus can be related to sample toughness, hardness or rigidity (Varela et al., 2007).

Adhesivity or adhesiveness was calculated as area under the negative part of the normal force versus compression distance curve (i.e., during withdrawal of the compression plate) as cited by Kim et al. (2009).

In figure 3 it is it can be seen the results of texture analyses profile where figure 3(A) shows the shear force and 3(B) the normal compression force. Basically, one simulates human mastication process and the other the force acquired from molar teeth in mastication process. Then it could be noticed that F1 (C0:B100) acquired the highest quantity force (N), to break the bars. However, formulations C25:B75, C50:B50, C75:B25, C100:B0 respectively did not significantly differ as showed in figure 4 (E) in terms of force (N).

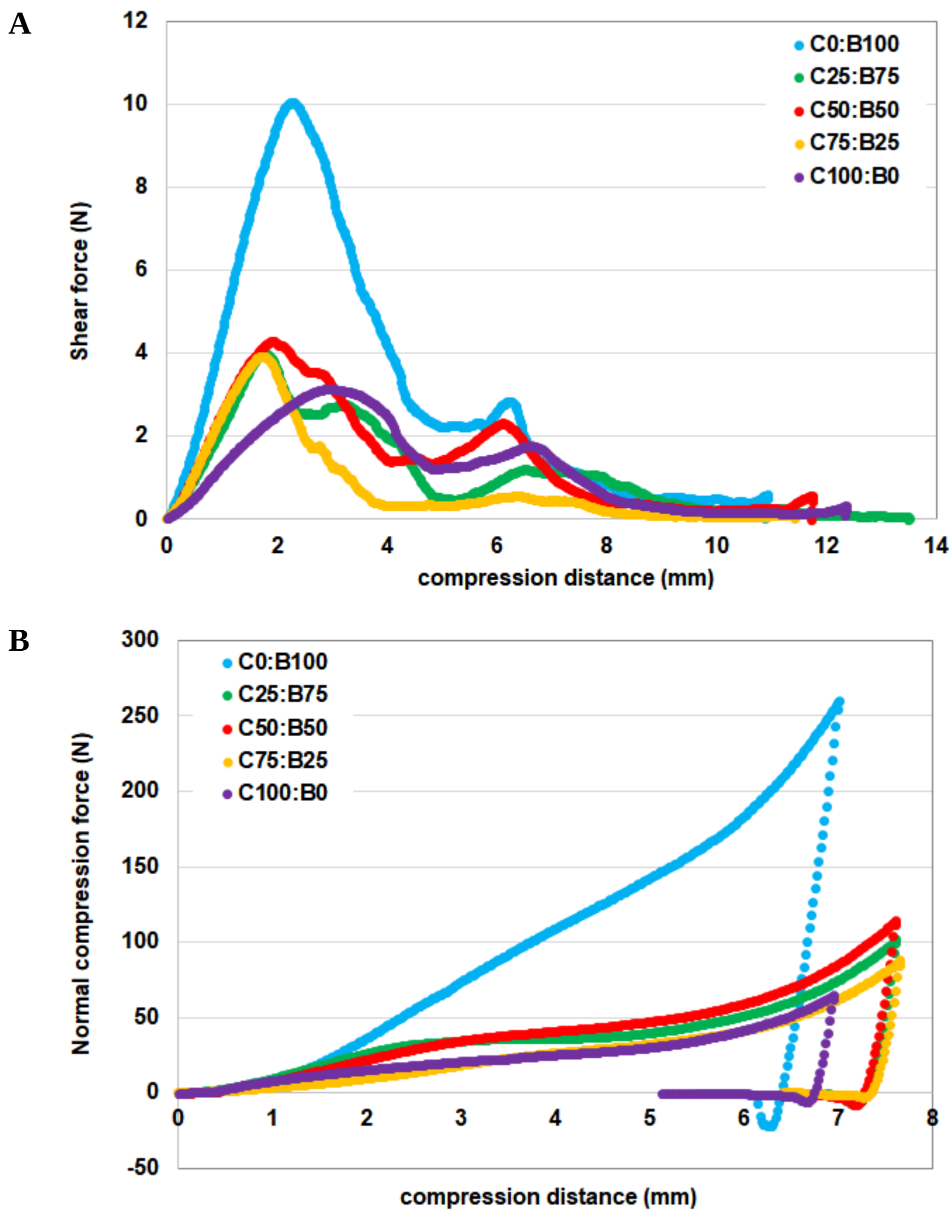


Figure 3. (A) Relation between shear force and compression distance and (B) Normal compression force and compression distance

Therefore, the normal force under compression tests can be related to the firmness results in figure 4(A), where firmness is expressed as force (N), it means that as much force is required less soft and yielding is the sample when it is pressed. Thus, C0:B100 reached 271.94 N to disintegrate and C100:B0, 57.17 N. While formulations with nuts and almonds mix did not differ among them. Yet, adhesiveness force was inversely related, C0:B100 had the minimum adhesive force while C50:B50, C75:B25 and C100:B0 had higher values and were not significantly different.

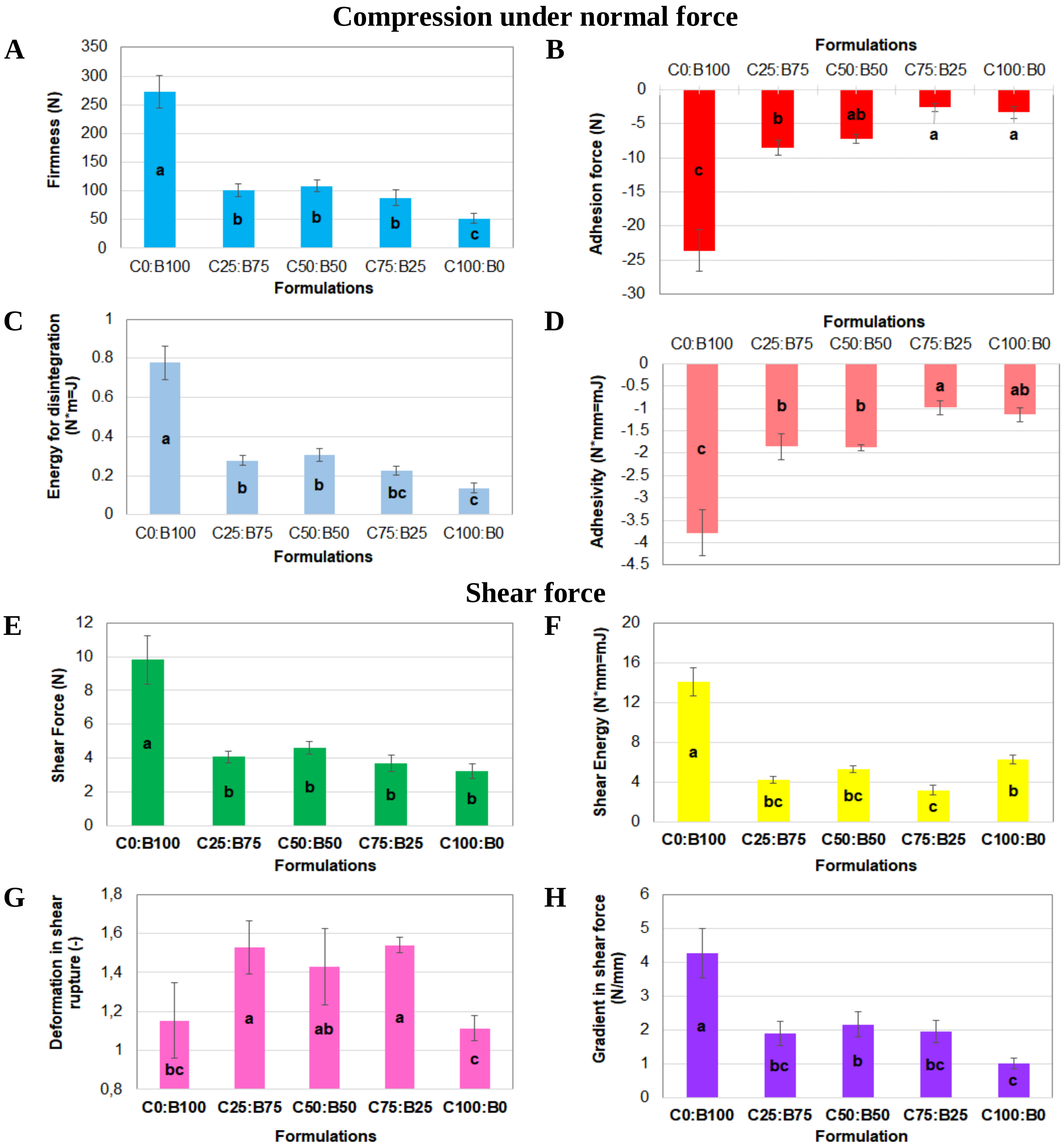


Figure 4. Textural parameters obtained from analysis using shear force and normal compression force for different formulations of nutritious bars based on Brazil nut and Baru almond. Normal force: Firmness (A), Adhesion force (B), Energy for disintegration (C) and Adhesivity. Shear forces: Shear force (E), shear energy (F), deformation in shear (G) and gradient in shear force (H).

3.5 Sensory evaluation and microbiological analysis

Prior the sensorial evaluation the samples were analyzed for presence of *Salmonella ssp* in 25 g and Coliforms at 45°C as acquired by item 4 from number 12 resolution (BRAZIL, 2001). The results showed absence of *Salmonella ssp*. and Coliforms at 45 °C less than 10 UFC. Then the samples were considered safe to follow to sensory evaluation.

The acceptability test accessed the opinion of 100 evaluators being 71%female and 29% male. A survey applied prior the analyses showed that 66% of the evaluators consume nut bars due to its flavor and 45% because they think it is a health snack. Yet, 99% answered that nuts and almonds are healthy food and 100% said that they would by nut bars with a mix of baru almonds and Brazil nuts.

The acceptability index for flavor, odor, color, texture and global perception is shown in figure 5. For flavor and texture the highest acceptability indexes were for C25:B75. Therefore, C0:B100 achieved the highest acceptability index for odor, color and global perception approximately (71%), (73%), (72%) respectively.

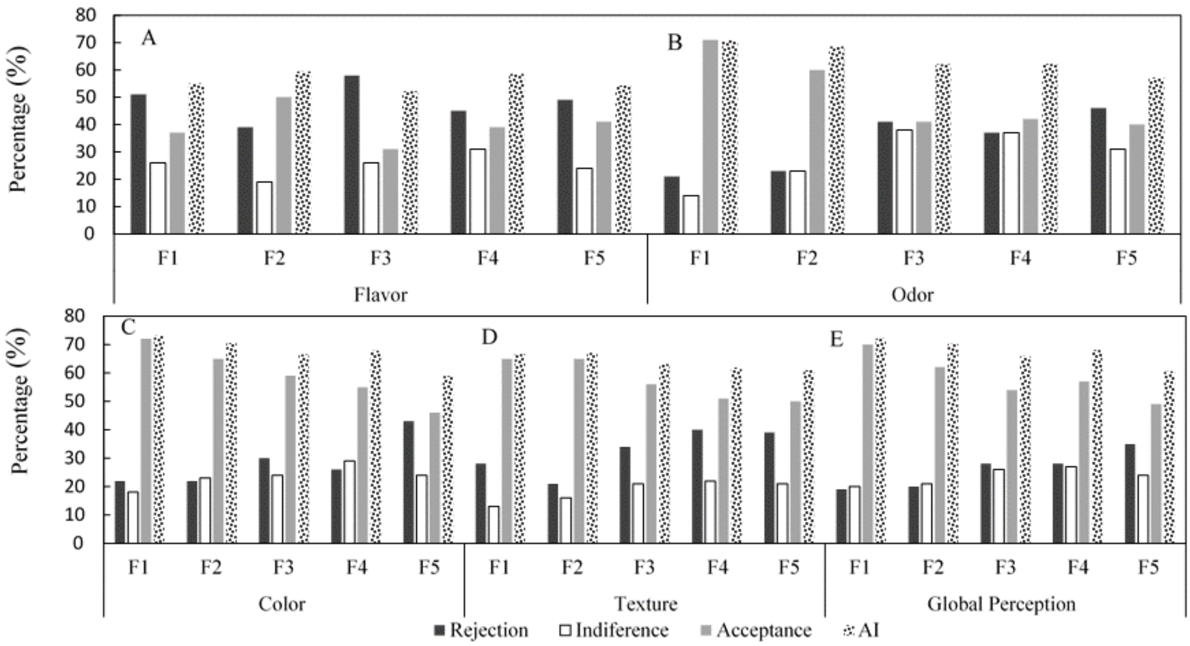
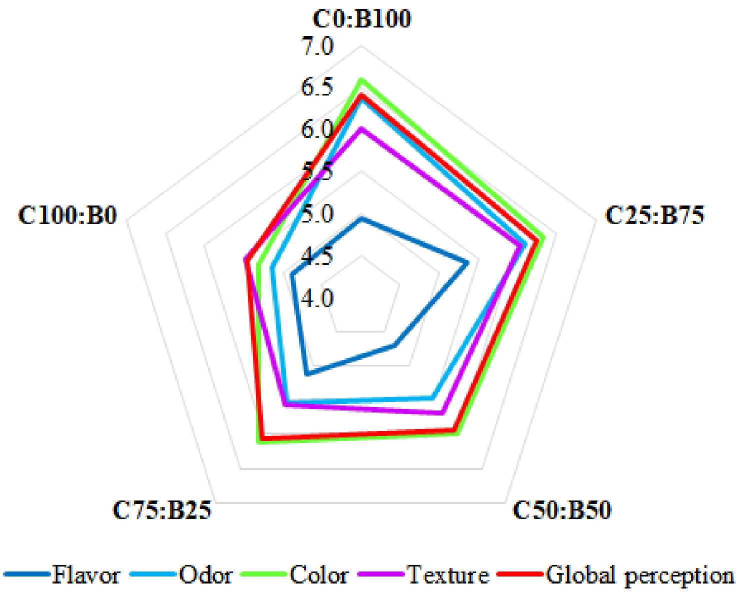


Figure 5. Acceptability averages and acceptability index for (A) Flavor, (B) Odor, (C) Color, (D) Texture, (E) Global perception among nutrition bars formulation based on baru almonds and Brazil nuts.

A



B

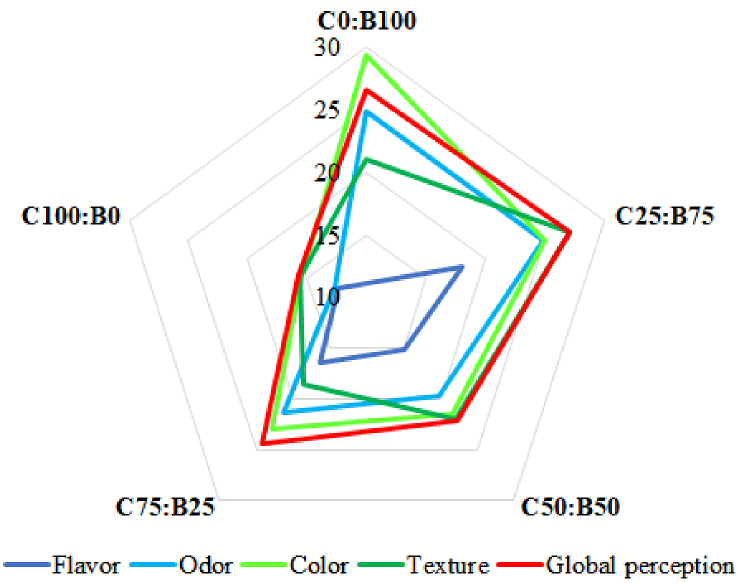


Figure 6. Comparison of Sensorial acceptability averages (A) and consensor index (%) (B) among formulation of nutrition bars based on baru almonds and Brazil nuts.

In addition, in figure 6(A) it can be seen that C25:B75 followed by C0:B100 reached higher averages for acceptance in the majority of the attributes. On the same hand in figure 6(B) the consensor (%) from the panel regarding the averages obtained were also higher for these formulations. The higher average for acceptance in this study was about 6, however it was lower than the average found by Silva et, al (2014) which was 7 for nutritious bars based on fruits.

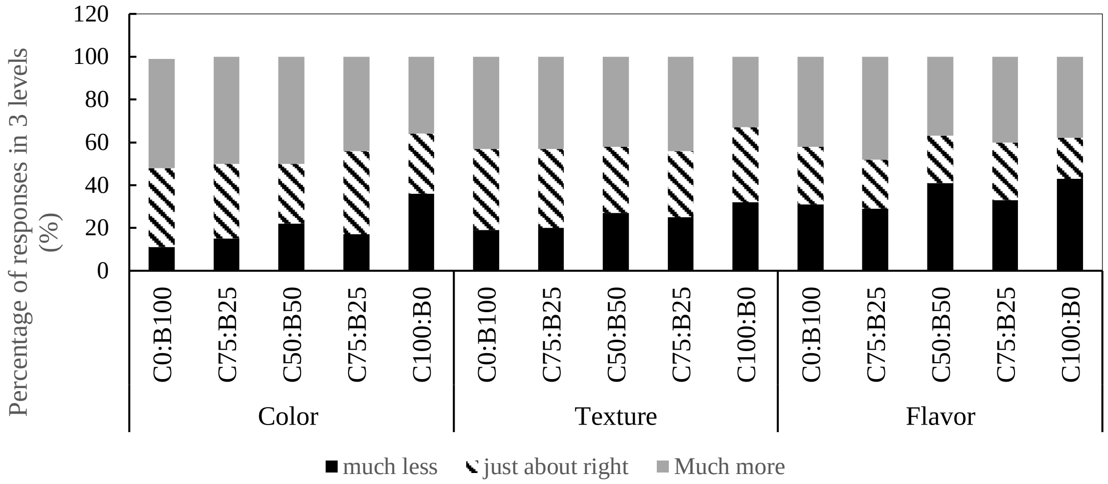


Figure 7. Frequency of responses for just about right scale between nutrition bars formulations based on baru almonds and Brazil nuts.

Just about right scale is a measurement which evaluate two opposite anchors and the midpoint is called Just About Right (JAR), which is assumed to be the ideal level considered by the evaluator (Li, Hayes & Ziegler, 2014).

The attributes of color, texture and flavor were accessed by the JAR scale and the frequency of answers are showed in figure 6. The color attribute was considered about right or much more about right for >60% of the judges for C0:B100 (88%), C25:B75 (85%), C50:B50 (78%), C75:B25 (83%) and C100:B0 (64%). Texture attributes also had a frequency > 60% for about right and much more about right for C0:B100 (81%), C25:B75 (80%), C50:B50 (73%), C75:B25 (75%) and C100:B0 (68%). Regarding, to flavor more than 50% of accessors considered the formulations about right or much more about right for C0:B100 (69%), F2 (71%), F3 (59%), F4 (67%) and F5 (57%).

The intent to by frequency is shown in figure 7, where about 30% of the evaluators reported that definitely would buy C0:B100 and C25:B75, and (12%), (19%) and (18%) definitely would buy C50:B50, C75:B25 and C100:B0 respectively. Formulation F5 had the highest frequency for definitely would not buy (25%). For the ordering preference test the critical value found for significance ($p<0.05$) was 61. The accessors were asked to rank the most preferred sample 5 points and the least 1. C25:B75 received the highest ranking, however; by performing the Friedman test, significant difference was verified for C25:B75 ≠ C50:B50 F3 and C25:B75 ≠ C100:B0. In the comments section 45% of the evaluators left a comment about the reason they accept or prefer a sample and the most cited words are shown in figure 8, where flavor was the most cited term followed by texture and color, as C25:B75 reached higher values for these terms, indeed the acceptance and preference was based primary on flavor, texture and color.

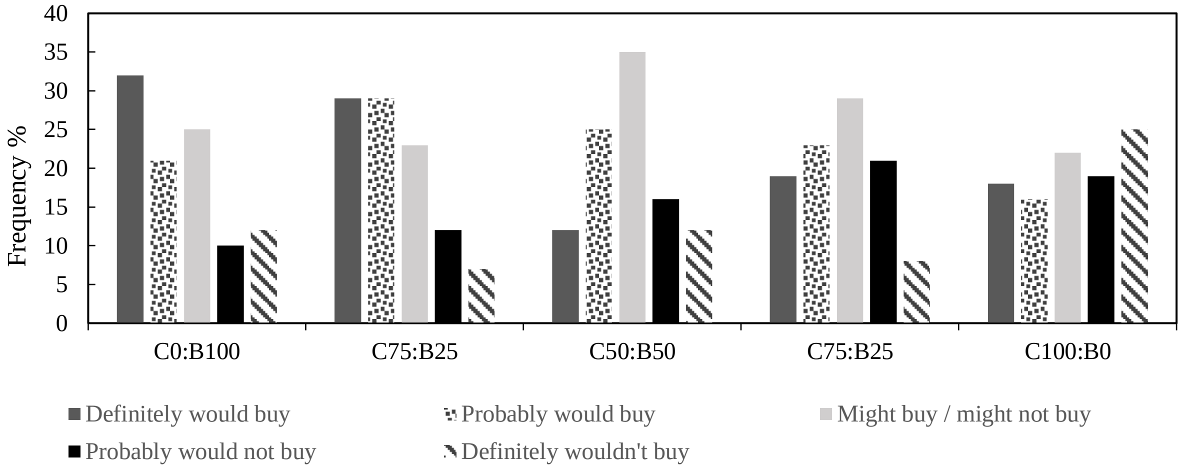


Figure 8. Purchasing intention frequency related to five nutrition bars formulations based on baru almonds and Brazil nuts.

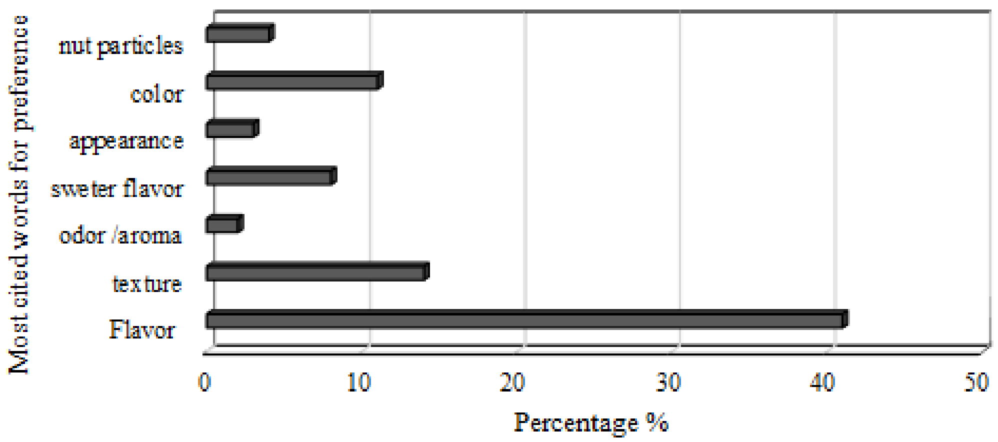


Figure 9. Most cited terms for preference in the comments section.

5. **CONCLUSION**

At the end of the study, it can be concluded that it was possible to obtain nutritious bars formulations based on Brazil nuts and baru almonds as the raw materials presented chemical and nutritional content in accordance with the values cited in the literature. The nutritious bars maintained the nutritional characteristics and bioactive compounds, all of which can be considered with high mineral content. Thus, taking into account all the results obtained, the formulations C25:B75 and C0:B100 would be the most indicated because these formulations also obtained better results in the sensorial tests. Production can be transferred to the cooperatives by encouraging solidarity trade among the communities, as the process is simple and can be carried out by small industries without the need of advanced technologies to process the nutritive bars based on baru almonds and Brazil nuts.

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