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# Development and quality evaluation of infant food with oregano essential oil for children diagnosed with cerebral palsy

Emilia Maria Barbosa Carvalho Kempinski [a, b, *], Ana Carolina Pelaes Vital [a], Jessica de Oliveira Monteschio [c], Simoni Alexandre [a], Karina Favoreto Nascimento [a], Grasiele Scaramal Madrona [a, d], Jane Martha Graton Mikcha [a, e], Ivanor Nunes do Prado [a, c]

[a] Food Science Post-Graduate Program, Universidade Estadual de Maringá, 87020-900 Maringá, Brazil
[b] Department of Physical Therapy, UNINGA-Centro Universitáro Ingá, 87035-510 Maringá, Brazil
[c] Animal Science Department, Universidade Estadual de Maringá, 87020-900 Maringá, Brazil
[d] Food Engineer Department, Universidade Estadual de Maringá, 87020-900 Maringá, Brazil
[e] Department of Clinical Analyzes and Biomedicine, Universidade Estadual de Maringá, 87020-900 Maringá, Brazil

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ABSTRACT

The development of a meat-based food, with a pasty texture, meets the need to improve the nutritional intake (mainly protein), in children diagnosed with cerebral palsy and dysphagia disorders. This study evaluated the use of oregano essential oil (EO) on the development of an infant food (IF) for children with cerebral palsy and dysphagia disorders, and the shelf-life (polyphenols content, antioxidant activity, lipid oxidation, color, pH, syneresis and adhesives) of the product during 28 days of storage. Four treatments were developed: Standard IF (STD), without EO; Control IF (CON), with BHT; IF with 0.01% EO (EO-0.01%), and IF with 0.05% EO (EO-0.05%). The results indicated that samples containing oregano EO presented higher antioxidant activity ($p < 0.01$) than CON and STD. Also, EO-0.05% presented the highest polyphenol content ($p < 0.02$). All samples showed an increase in malonaldehyde value during storage ($p < 0.001$), however, this increase was more accelerated for the STD and CON. Also, STD, CON and EO-0.01% showed a reduction in syneresis and all treatments showed a reduction in adhesiveness during storage. Sample EO-0.05% showed better results in most of the analyses compared to the other treatments, demonstrating that it is possible to use a natural compound in the development of this product.


## 1. Introduction

In many countries, children do not have all the necessary nutrients in their diet, and the traditional complementary foods (supplementation) are most often based on cereals, such as maize, rice and wheat, which do not satisfy the infant's energy needs (Sanni, Onilude, & Ibidapo, 1999). Oropharyngeal dysphagia, or impaired feeding, has been frequently cited in the literature as an important factor influencing growth, nutritional status and respiratory health in children with cerebral palsy (CP) (Calis et al., 2008).

With a prevalence of about 2 per 1000 live-births, CP is one of the most common childhood-onset disabilities (Odding, Roebroeck, & Stam, 2006). According to Benfer et al. (2014), p. 93.8% of children with CP, had oral phase impairments during eating or drinking, and 78.5% in controlling saliva. These findings highlight the importance of considering feeding efficiency as an early marker for children that need a nutritional supplementation or diet modification (Benfer et al., 2014).

For dysphagic patients, whose energy and dietary protein requirements, with adapted texture, are not achieved, the balance of ingested nutrients is necessary to overcome this nutritional deficit. Thus, the texture suitability of the food products makes the swallowing process safe and viable (Fernández et al., 2015).

A practical investigation that is focused on the development of a food with a predominantly pasty texture, meets the need to improve the nutritional protein intake, in children diagnosed with CP and dysphagia disorders. In particular, dietary supplementation with texture-modified bovine meat-based products, may significantly increase the protein intake of people with dysphagia (Dias, Goulart, Freire, Becker, & Vaz, 2015).

* Corresponding author. Food Science Post-Graduate Program, Universidade Estadual de Maringá, 87020-900 Maringá, Brazil.
*E-mail address:* emiliakempinski@gmail.com (E.M.B.C. Kempinski).

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Regarding the quality and safety of meat products, there is a need to produce foods with less synthetic additives but which still retain their original characteristics and possess an extensive shelf life (Taghvaei & Jafari, 2015). In food formulation, the most common synthetic antioxidants used are butylated hydroxyanisole, butylated hydroxytoluene (BHT), propyl gallate, and tert-butylhydroquinone. However, there is currently a concern about the possible carcinogenic effects of synthetic antioxidants (Carocho, Barreiro, Morales, & Ferreira, 2014). Thus, the use of aromatic plants, which contain essential oils (EOs), can be an important alternative for food preservation.

EOs are natural plant products that exhibit antimicrobial and antioxidant properties (Atarés & Chiralt, 2016). Moreover, many EOs are considered to be 'Generally Recognized as Safe' (GRAS) and are approved for use in foods by the Food and Drug Administration (FDA, 2015). Moreover, aromatic herbs and spices, and their extracts, are common ingredients in food preparation and familiar to consumers. Oregano EO, which is rich in carvacrol, possesses considerable antioxidant activity (Bentayeb, Vera, Rubio, & Nerín, 2014; Tomaino et al., 2005; Vekiari, Oreopoulou, Tzia, & Thomopoulos, 1993) and can be successfully incorporated into food formulations.

Thus, this study aimed to develop an infant food containing oregano EO, for children with dysphagia and evaluate its shelf-life (polyphenols content, antioxidant activity, lipid oxidation, color, pH, syneresis and adhesives) during 28 days of cold storage.

## 2. Material and methods

### 2.1. Material

Gallic acid, 2,2-azinobis-3-ethylbenzotiazoline-6-sulfonic acid (ABTS), sodium carbonate, potassium persulfate, trichloroacetic acid (TCA), hydrochloric acid (HCl), 1,1,3,3-tetramethoxypropane, and BHT, were from Sigma-Aldrich (USA). Thiobarbituric acid (TBA) was from Alfa Aesar® A Johnson Matthey Company (USA). Food ingredients including bovine meat [*Longissimus dorsi*, (LD)], pure potato (Knorr), water, urucum (Kitano), salt (Cisne, light - 50% less sodium) and garlic powder, were purchased at a local market. Oregano EO was from Ferquima® (Brazil).

### 2.2. Meat for food infant formulation

The meat was obtained from eight crossbred young bulls (½ Angus × ½ Nellore), originating from a single father, finished in a feedlot for 62 days and slaughtered at 18-months old. The average live weight was 482 ± 27.87 kg. After slaughter, the carcasses were chilled at 4 °C for 24 h. Then, the LD was excised from the left half of the carcass from the seventh to the last lumbar vertebrae. The LD was transported to the laboratory, vacuum-packaged and frozen intact at −18 °C, until analysis (less than 1 month of storage).

### 2.3. Preparation of the treatments

The infant food was prepared by pressure cooking the LD (262 g), as medium cubes, with 200 mL of water, for 15 min. Then, the meat was processed (NMP08–500 W Mondial processor) for 2 min. The ingredients (Table 1) were placed in a pan and cooked for 5 min, to form a homogeneous mass.

The treatments were defined as follows: addition of 0.01% BHT (CON), 0.01% oregano EO (EO-0.01%), 0.05% oregano EO (EO-0.05%) and without addition of antioxidant (STD). Each sample, with or without the respective antioxidants, was individually packed in 30-g glasses with metal lids (pre-autoclaved at 121 °C for 15 min; PHOENIX vertical 75l). Three independent replicates were performed for each treatment (triplicates) and the experiment was performed in duplicate. After packing, the samples were pasteurized in a water bath (60 °C) for 30 min and stored at 4 °C. Samples STD, CON, EO-0.01% and EO-0.05%, were randomly removed at 1, 3, 7, 14, 21 and 28 days of storage, for analysis.

**Table 1**
Infant food ingredients.

| Ingredients [%] | Infant food | | | |
|---|---|---|---|---|
| | STD[a] | CON[b] | OE-0.01%[c] | OE-0.05%[d] |
| Meat Bovine (*Longissimus dorsi*) | 29.00 | 29.00 | 29.00 | 29.00 |
| Flat potato (*Solanum tuberosum*) | 8.72 | 8.72 | 8.72 | 8.72 |
| Garlic *(Allium sativum)* | 0.528 | 0.528 | 0.528 | 0.528 |
| Hot Water | 60.50 | 60.49 | 60.49 | 60.45 |
| NaCl | 0.352 | 0.352 | 0.352 | 0.352 |
| Butylated hydroxytoluene (BHT) | – | 0.01 | – | – |
| Oregano Oil essential | – | – | 0.01 | 0.05 |
| Urucum *(Bixa orellana)* | 0.90 | 0.90 | 0.90 | 0.90 |

*Values expressed as a percentage.
[a] STD - Standard Infant Food, without antioxidant.
[b] CON - Control Infant Food, with BHT.
[c] EO-0.01% – Infant Food with 0.01% of oregano essential oil.
[d] EO-0.05% – Infant Food with 0.05% of oregano essential oil.

### 2.4. Total phenolic content (TPC) and antioxidant activity (ABTS radical scavenging)

The infant food phenolic content and antioxidant activity were analyzed at 1 day of storage, after extraction (1:2 w/v with 100% methanol). Extracts were obtained by homogenization (vortexed for 1 min), centrifugation (4000 rpm, 25 °C, 15 min) and filtration (filter paper). The extracts were used directly for analyses.

#### 2.4.1. TPC (Folin-Ciocalteu assay)

The TPC was determined according to Singleton and Rossi (1965), with modifications. An aliquot of each extract (125 μL) was mixed with 125 μL of Folin-Ciocalteu reagent (1:1 deionized water) and 2250 μL sodium carbonate (28 g/L). The solutions were then incubated in the dark at 25 °C for 30 min and the absorbance was measured at 725 nm using a spectrophotometer (Evolution 201 UV-visible spectrophotometer, Thermo Scientific). Results were expressed as mg gallic acid equivalent (GAE)/g of sample. A gallic acid standard curve (0–300 mg/L) was prepared.

#### 2.4.2. ABTS radical scavenging assay

The ABTS assay was conducted according to Re et al. (1999), with modifications. ABTS+ was generated through the interaction of 7 mM (5 mL) ABTS solution with 88 μL of 140 mM potassium persulfate. The mixture was incubated in the dark at 25 °C for 16 h and, then, diluted with ethanol to an absorbance of 0.70 ± 0.02. Samples (30 μL) were mixed with the ABTS+solution (3000 μL) and the absorbance was recorded at 734 nm, after 6 min. The radical scavenging activity (%) was calculated as follows:

$$\textit{ABTS radical scavenging activity}\ (\%) = \left(1 - \left(\frac{A_{sample\ t}}{A_{sample\ t=0}}\right)\right) \times 100$$

where $A_{sample\ t\ =\ 0}$ is the absorbance of the sample at time zero, and $A_{sample\ t}$ is the absorbance of the sample over time.

### 2.5. Lipid oxidation

The malonaldehyde (MDA) content was quantified using the