Revista Brasileira de Higiene e Sanidade Animal
Brazilian Journal of Hygiene and Animal Sanity
ISSN: 1981-2965

Nitrate, sodium and macronutrients in transition foods for infants and young children of the Artiype baby food of vegetables with meats

Nitrato, sódio e macronutrientes em alimentos de transição para lactentes e crianças pequenas da Artiype papinha de vegetais com carnes

Lorena Natalino Haber Garcia[1], Aryele Nunes da Cruz Encide Sampaio[1], Bruna Godoi Castro[1], Marise Santiago Velame[1], Amanda de Oliveira Santos[1], Evelyn Fernanda Flores Caron[1*], Camila Koutsodontis Cerqueira-Cézar[1], Eduardo Delbon Baldini[2], Fábio Sossai Possebon[2], Juliano Gonçalves Pereira[2], Otávio Augusto Martins[3]

Abstract Transitional foods for infants and children of early childhood, also popularly known as baby-food, are used in order to complement the diet, gradually introducing new sources of nutrients to children in the weaning phase. The objective is to evaluate the chemical and biochemical quality of transitional foods for infants and young children such as vegetable and meat baby-food (VMBF) and vegetable and chicken baby-food (VCBF). 20 samples of VMBF and VCBF were analyzed. The levels of nitrate, sodium, pH, macronutrients (protein, lipid and carbohydrate), total caloric value (TCV), humidity, fixed mineral residue (FMR) and solid matter (SM) were determined in duplicate. The results showed that the two types of baby-food (VMBF and VCBF) did not show statistical differences ($p > 0.05$). Regarding the current legislation, it was found that 100% of the samples of VMBF and VCBF presented within the reference values for the pH and SM tests. The VMBF samples showed percentages of 25%, 100%, 25% and 25% for the nitrate, sodium, protein and TCV assays that were outside the permitted values, respectively. The samples of VCBF, however, presented percentage indexes of 40%, 80% and 40% for the tests of nitrate, sodium and protein outside the established reference standards, respectively. It is concluded that the high levels of nitrate and sodium are worrisome, being necessary the active inspection by Organs regulating agencies in relation to these foods due to its importance in child development.

Keywords: *Macronutrients, Sodium, Baby-food.*

---

http://dx.doi.org/10.5935/1981-2965.20240001
Recebido em 25.2.2024 Aceito em 30.06.2024

*Corresponding author: evelyn.fernanda@unesp.br
[1]Postgraduate student - Department of Animal Production and Preventive Veterinary Medicine, São Paulo

State University (UNESP), School of Veterinary Medicine and Animal Science, Prof. Dr. Walter Mauricio Correa Street, Unnumbered. Botucatu City, São Paulo State. Brazil. E-mail: soap.fmvz@unesp.br.

[2]Professor of Veterinary Medicine - Department of Animal Production and Preventive Veterinary Medicine, São Paulo State University (UNESP), School of Veterinary Medicine and Animal Science, Prof. Dr. Walter Mauricio Correa Street, Unnumbered. Botucatu City, São Paulo State. Brazil. E-mail: soap.fmvz@unesp.br.

[3]Professor of Physical Chemistry Applied to Foods of Animal Origin - Department of Animal Production and Preventive Veterinary Medicine, São Paulo State University (UNESP), School of Veterinary Medicine and Animal Science, Prof. Dr. Walter Mauricio Correa Street, Unnumbered. Botucatu City, São Paulo State. Brazil. E-mail: otavio.a.martins@unesp.br.

1. Introduction

According to the Agência Nacional de Vigilância Sanitária (ANVISA), transition foods are understood to mean industrialized foods for direct use or used in homemade preparations, used as a complement to breast milk or modified milk introduced in the feeding of infants and children of early childhood. The purpose of this food is to promote a progressive adaptation to common foods, making a balanced diet appropriate to your needs, respecting your physiological maturity and your neuropsychomotor development [1].

Currently, there is a growing concern about the quality of food consumed in children's nutrition, especially during the beginning of the complementary feeding phase, which demands greater care because it is the moment when the introduction of new food sources occurs [2].

One of the main adverse effects of nitrates for human health, especially for babies, is infantile methaemoglobinaemia [3].

Metahemoglobinemia is a pathology that results from the oxidation of hemoglobin to methemoglobin by nitrites, ceasing to be functional for the transport of oxygen to the tissues [4]. This pathology can cause cyanosis, weakness, hypoxia, and depression of the central nervous system and can, in more severe cases, cause death [5,6]. Regarding sodium intake, the maximum allowed by law is 200 mg Na/100 g of product ready for consumption [1]. When consumed in excess in childhood, it can lead to increased blood pressure in adolescence and reflected in adulthood [7].

The macronutrients are those necessary to the organism daily and in large quantities. Providing energy and fundamental components for the growth and maintenance of the body, they are composed of proteins, carbohydrates and lipids [8]. The Institute of Medicine recommends for infants, in relation to macronutrients, 9.1 g/day of protein or 5 % - 20 % of the total energy value (TEV), 30 % - 40 % of TEV lipids and 45 % - 65 % carbohydrates from the TEV [9]

The aim of this study is to evaluate the chemical and biochemical quality of transition foods for infants and early childhood children, such as vegetable and beef baby-food (VMBF) and vegetable and chicken baby-food (VCBF).

2. Material and methods

2.1. Samples

A total of 20 samples of transition foods for infants and early childhood children of the type of vegetable and meat baby-food were analyzed. Transitional food treatments for infants and young children were (a) vegetable and beef baby-food (VMBF) and (b) vegetable and chicken baby-food (VCBF). The vegetables used at random in the manufacture of homemade baby-food were beets, yam, potatoes, carrots, lentils, squash and broccoli. Homemade baby-food were sent to the Laboratório de Físico-Química do Serviço de Orientação à Alimentação Pública (SOAP) of the Department of Veterinary Hygiene and Public Health of the Faculty of Veterinary Medicine and Animal Science at Universidade Estadual Paulista (UNESP), Campus Botucatu, São Paulo, Brazil, by those interested in 4°C coolers. Laboratory tests were performed in duplicates.

2.2. Spectrophotometric determination of nitrate

10 g of the crushed and homogenized sample was weighed in a 200 mL beaker. Added 5 mL of 5 % sodium tetraborate solution. After mixing with the aid of a glass stick, 50 mL of pure water was added and the solution was homogenized. The solution was heated in a water bath at 80ºC for 20 min with constant agitation and aid of a glass stick. He proceeded in the same way with a blank reagent, without the sample. After heating, with the aid of a funnel and glass rod, transferred the solution to a 200 mL volumetric flask, 5 mL of 15 % potassium ferrocyanide and 5 mL of 30 % zinc acetate solution were added, stirring by rotation each addition of reagent and made up to 200 mL with distilled water. After 15 min, the solution was filtered on filter paper. He transferred 10 mL of the prepared and filtered sample in a 50 mL volumetric flask. Added 5 mL of 5% sulfanilamide reagent. After 5 min, added 3 mL of 0,5% NED reagent. The flask volume was made up with distilled water and the solution was homogenized.

After 15 min and performed the reading on a spectrophotometer at 540 nm against the reagent blank [10].

2.3. Protein determination

This analysis is divided into three stages. The first is digestion. To do this, 0,5 g of the sample was weighed on tissue paper and transferred (paper + sample) to a Kjeldahl tube, 5 mL of sulfuric acid (d = 1.825 g/mL) and ± 2,0 g of catalytic mixture. The sample was digested in a digester block at 400°C for a period of 6 h, until a blue-green transparent liquid was obtained. The tube was removed from the heating and, after cooling, ± 5 mL of distilled water was added [10].

The second step consists of distillation, for this purpose, the Kjeldahl tube was adapted to a nitrogen distiller and approximately 25 mL of 45

% sodium hydroxide was added. To receive the distillate, a 250 mL Erlenmeyer flask containing 10 mL of 0,1 N sulfuric acid was added with 4 to 5 drops of the 0,01 % methyl red indicator. Distillation was carried out for 5 min after the beginning of bubbling.

Finally, in the third and last stage, the distillate was titrated with 0,1 N sodium hydroxide. The volume spent on the titration was recorded so that the following calculation could be made: % Protein = V x 0.14 x f / P. Where V is the difference between the number of mL of 0.1 N sulfuric acid and the number of mL of 0.1 N NaOH spent on titration, P is the number of g in the sample and f correspond to the nitrogen conversion factor total protein, which for milk and dairy products is 6,38 [10].

2.4. Determination of lipid and dry extract fat (GES)

2 g of the sample, properly dried in an oven at 105°C, were weighed in a Soxhlet cellulose cartridge. The cartridge was transferred to the extractor apparatus type Soxhlet TE 044 Tecnal® coupled in a flask, previously tared at 105ºC, with 150 mL of ethyl ether p.a.. The sample was kept under heating at 80°C for 6 h (4 - 5 drops /second). The ether was distilled and the flask with the residue was transferred to the oven at 105ºC for 1 h. It was cooled in a desiccator to room temperature and weighed. The formula was used: Lipids (%) = 100. N / P. Where: N = number of g of lipids; and, P = number of g in the sample. GES (%) = 100 x Lipid / ES. GES = fat from the dry extract; and ES = dry extract (ES = 100 - moisture) [10].

2.5. Determination of humidity

5 g of the homogenized sample was weighed in a porcelain crucible of known weight and previously tared. The porcelain crucible was placed in a greenhouse at 105°C for a period of 4 h. After this period, it was cooled in a silica gel desiccator to room temperature and its weight was recorded. % Humidity = 100 x N / P. Where N is the number of g of moisture (loss of mass in g) and P is the number of g in the sample [10].

2.6. Determination of solid matter

The solid matter was determined by the difference between 100 and the result obtained by the moisture content [10].

2.7. Determination of fixed mineral residue (FMR)

1 g of the sample was weighed in a porcelain crucible of known weight and previously tared. After this step, the crucible was placed in a muffle at 550 ° C for a period of 6 h until complete incineration of organic matter, the crucible was then cooled in a silica gel desiccator to room temperature and its weight was noted. Calculation: % FMR = 100 x N / P. Where N corresponds to the number of g of ash and P is the number of g of the sample [10].

2.8. Determination of carbohydrate

The carbohydrate content was determined by the difference between 100 and the sum of the protein, lipid, humidity and embers [10].

2.9. PH determination

A bench pH meter (KASVI®) previously calibrated with standard solutions was used according to the manufacturer's instructions. For the measurement in aqueous medium the sample was placed in a 100 mL glass beaker, sufficient pure water was added to cover it, homogenizing it in sequence with a glass stick. The reading was made on the device.

2.10. Determination of total caloric value (TCV)

Carbohydrates, proteins and lipids were considered to generate 4, 4 and 9 Kcal per g, respectively. The TCV was calculated for each sample of VMBF and VCBF and the result of the sum of the calories corresponded to their TCV. Kcal / 100g = (protein x 4) + (carbohydrate x 4) + (lipids x 9) [11].

2.11. Determination of sodium by the Mohr Method

1 g of the sample was weighed in a porcelain crucible and the FMR was subsequently obtained. The ashes were dissolved with two drops of 1 + 1 hydrochloric acid solution and filtered with pure hot water in a 250 mL Erlenmeyer until the volume of ± 150 mL was completed. A spoonful of calcium carbonate p.a. was added to the filtrate while it was still hot. After cooling, 1,0 mL of 5 % potassium chromate solution was added as a colorimetric indicator, proceeding with titration with a 0,1 N silver nitrate solution until brick staining.

The volume spent on titration was noted. The following calculation was performed: % NaCl = V xfx 0.585/P. V is the number of mL of 0,1 M silver nitrate solution spent on the titration, f is the factor of the silver nitrate solution at 0,1 M and P is the g of the sample (IAL, 2008).

The percentage of sodium was obtained by the following formula: Na (%) = 23 x NaCl (%)/58.443.

The molecular weight of NaCl = 58.443 g/mol and atomic weight of sodium = 23 g/mol.

3. Results

Table 01 shows that the mean values of nitrate (p = 0,6317), sodium (p = 0,4007) and pH (p = 0,1762) did not show statistically significant differences in VMBF and VCBF.

Table 01 - Mean ± standard deviation of the concentration of nitrate (mg/kg), sodium (mg/100 g) and pH of VMBF and VCBF. Statistical analysis (Anova) complemented with the Tukey test at a 5% level.

Assay	***P***	**Type**	
		VMBF	**VCBF**
Nitrate (mg/kg)	0,632	185,75 ± 117,77 a	144,56 ± 131,20 a
Sodium (mg/100 g)	0,401	266,52 ± 7,45 a	298,98 ± 71,25 a
pH	0,176	5,95 ± 0,14 a	6,08 ± 0,12 a

In Table 02, the mean values of protein (p = 0,9191), lipid (p = 0,9956), carbohydrate (p = 0,6457), TCV (p = 0.6777), humidity (p = 0,4675), FMR (p = 0,3767) and SM (p = 0,4675) also did not show significant statistical differences in VMBF and VCBF.

Table 02 - Mean ± standard deviation of the concentration of macronutrients (protein, lipid and carbohydrate), total caloric value (TCV), humidity, fixed mineral residue (FMR) and solid matter (SM) of VMBF and VCBF. Statistical analysis (Anova) complemented with the Tukey test at a 5% level.

Assay	***P***	**Type**	
		VMBF	**VCBF**
Protein (%)	0,919	3,52 ± 1,19 a	3,43 ± 0,55 a
Lipid (%)	0,996	4,91 ± 2,08 a	4,92 ± 2,30 a
Carbohydrate (%)	0,646	5,71 ± 1,43 a	6,60 ± 3,46 a
TCV (kcal/100 g)	0,678	81,07 ± 14,17 a	84,38 ± 8,76 a
humidity (%)	0,468	85,13 ± 1,23 a	84,22 ± 2,09 a
FMR (%)	0,377	0,74 ± 0,02 a	0,83 ± 0,20 a
SM (%)	0,468	14,87 ± 1,23 a	15,78 ± 2,09 a

Table 03 shows that 100% of the VMBF samples presented within the reference values of BRASIL (1998) for the pH and SM tests. However, the VMBF samples showed percentage rates of 25%, 100%, 25% and 25% for the nitrate, sodium, protein and TCV assays, respectively, which were outside the values allowed [1].

Table 03 - Percentage (%) of pH, nitrate (mg kg-1), sodium (mg / 100 g), protein (g / 100 g), solid matter (%) and total caloric value (kcal / 100 g) of VMBF and VCBF of the values allowed according to Ordinance n. 34 of January 13, 1998 from the Ministry of Health [1].

Assay	**Reference**	**Type**	
		VMBF	**VCBF**
pH	> 7	0%	0%
	≤ 7	100%	100%
Nitrate	> 250 mg kg^{-1}	25%	40%
	≤ 250 mg kg^{-1}	75%	60%
Sodium	> 200 mg/100 g	100%	80%
	≤ 200 mg/100 g	0%	20%
Protein	≥ 3 g/100 g	75%	60%
	< 3 g/100 g	25%	40%
Solid matter	≥ 12 %	100%	100%
	< 12 %	0%	0%
Total caloric value	≥ 70 kcal/100 g	75%	100%
	< 70 kcal/100 g	25%	0%

The VCBF samples were 100% within the values allowed by BRASIL (1998) for the pH, SM and TCV tests. However, the VCBF samples showed percentages of 40%, 80% and 40% for the nitrate, sodium and protein assays, respectively, outside the reference standards established [1] as shown in Table 03.

4. Discussion

The high levels of the nitrate ion obtained in our study, may be related to the nitrogen nitrate present in fertilizers, used in large quantities in order to promote the growth of crops, to accelerate the production of vegetables and to improve the characteristics of the crops. Leafy vegetables such as lettuce and spinach usually have higher concentrations of nitrates, while storage organs such as potatoes, carrots, onions, pea seeds and pods and the bean plant have lower concentrations [12]. Green leafy vegetables have high levels of nitrates, which can be the high cause of these ions in baby-food [12,13].

This high level of sodium reported in our study is worrying, since high levels of this ion can cause an increase in blood pressure in the first year of life and in adolescence [14,15]. Also highlighted in their study that the transition foods made at home had a high sodium content and stated that in the case of families of low socioeconomic level this content was higher [14].

According to the Brazilian Society of Pediatrics, salt should not be added to porridge, the content intrinsic to the foods used in the preparation being sufficient [16].

The protein levels were below the minimum level required in our research, prepared a homemade vegetable and chicken liver baby-food, found a protein content of 4,8 %, that is within the recommended value for baby-food [17]. This macronutrient is extremely important in this phase of life as they are important nutrients for building and maintaining tissues, forming enzymes, hormones and antibodies, in addition to providing energy and regulating metabolic processes [18].

The caloric value was below the minimum values in 25% of the VMBF, which can be justified by the protein values, which were also below the lower limit, directly influence the energy calculation.

5. Conclusions

There were no statistical differences between VMBF and VCBF baby-food. The levels of the nitrate ion were higher than those allowed by the legislation. The sodium levels present in vegetable and beef baby-food were above the level acceptable by the legislation in all samples analyzed, and those with pork by 80%. The high levels of nitrate and sodium in the transition diet of infants and young children are of concern.

The protein value below the recommended in 25% of VMBF and 40% of VCBF can lead to a deficiency in child development caused by the lack of this essential macronutrient.

Periodic inspection of this type of product by inspection agencies (ANVISA) is necessary, aiming to guarantee the health and quality of life of children in the growth and development phase.

Acknowledgments

Serviço de Orientação à Alimentação Pública (SOAP) and Fundação de Apoio aos Hospitais Veterinários da UNESP (FUNVET).

References

AVOZONI PATRÍCIA, SPINELLI RBAGGIO, ZEMOLIN GPEGORARO, ZANARDO VPSKZYPEK. Avaliação da ingestão de sódio e o risco de hipertensão arterial em adolescentes das escolas públicas de Erechim-RS. 2014; 38:141–50.

BRASIL. Ministério da Saúde. Secretaria de Vigilância Sanitária. Portaria SVS n 34. Regulamento técnico para fixação de identidade e qualidade de alimentos de transição para lactentes e crianças de primeira infância. 1998.

BRADBERRY S. Methaemoglobinaemia. Medicine 2012; 40:59–60. https://doi.org/10.1016/j.mpmed.2011.11.011.

BUTLER AR, FEELISCH M. Therapeutic Uses of Inorganic Nitrite and Nitrate. **Circulation** 2008; 117:2151–9. https://doi.org/10.1161/CIRCULATIONAHA.107.753814.

CARDOSO R DE CV, GÓES JÂW, ALMEIDA RC DE C, GUIMARÃES AG, BARRETO DL, SILVA SA DA, ET AL. Programa nacional de alimentação escolar: há segurança na produção de alimentos em escolas de Salvador (Bahia)? **Revista de Nutrição** 2010; 23:801–11. https://doi.org/10.1590/S1415-52732010000500010.

CAMPOS VJ. Papa caseira de hortaliças e fígado de frango, fonte de ferro para lactentes: Arquivos Público-457.pdf(531.92 KB) 2010-10-27 Dissertação de mestrado

CARDOSO MA. Nutrição Humana. Rio de Janeiro: Guanabara Koogan; 2013.

EFSA. Nitrate in vegetables - Scientific Opinion of the Panel on Contaminants in the Food chain. **EFSA Journal** 2008; 6:689. https://doi.org/10.2903/j.efsa.2008.689.

EFSA. Statement on possible public health risks for infants and young children from the presence of nitrates in leafy vegetables**. EFSA Journal** 2010;8. https://doi.org/10.2903/j.efsa.2010.1935.

IARC Working Group on the Evaluation of Carcinogenic Risks to Humans. IARC monographs on the evaluation of carcinogenic risks to humans. Ingested nitrate and nitrite, and cyanobacterial peptide toxins. **IARC Monogr Eval Carcinog Risks Hum** 2010;94:v–vii, 1–412.

INSTITUTO ADOLFO LUTZ. Métodos físico-químicos para análise de alimentos. **Instituto Adolfo Lutz** 2008.

FIDELIS CMF, OSÓRIO MM. Consumo alimentar de macro e micronutrientes de crianças menores de cinco anos no Estado de Pernambuco, Brasil. **Revista Brasileira de Saúde Materno Infantil** 2007; 7:63–74. https://doi.org/10.1590/S1519-38292007000100008.

GREER FR, SHANNON M. Infant Methemoglobinemia: The Role of Dietary Nitrate in Food and Water. **Pediatrics** 2005; 116:784–6. https://doi.org/10.1542/peds.2005-1497

PORTELLA MB, MORAIS TB DE, MORAIS MB DE. Excesso de sódio e déficit de ferro em alimentos de transição. **J Pediatr** (Rio J) 2010;86:303–10. https://doi.org/10.1590/S0021-75572010000400010.

SARNO F, CLARO RM, LEVY RB, BANDONI DH, FERREIRA SRG, MONTEIRO CA. Estimativa de consumo de sódio pela população brasileira, 2002-2003. **Rev Saude Publica** 2009; 43:219–25. https://doi.org/10.1590/S0034-89102009005000002.

SOCIEDADE BRASILEIRA DE PEDIATRIA (SBP). Manual de orientação para a alimentação do lactente, do pré-escolar, do escolar, do adolescente e na escola. 2012. desenvolvimento, análise química de nutrientes e avaliação de aceitação de pelas crianças e suas mães.

Universidade Federal de São Paulo, 2010.

TIRAPEGUI J, ROGERO MM, LAJOLO FM. Proteínas e Aminoácidos. Ciências nutricionais, São Paulo: **Savier**; 2008, p. 53–79.

TRUMBO P, SCHLICKER S, YATES AA, POOS M. Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein and Amino Acids. **J Am Diet Assoc** 2002; 102:1621–30. https://doi.org/10.1016/S0002-8223(02)90346-9.