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Microbiological analysis of lettuce (Lactuca sativa) from conventional and organic cultivation commercialized at fairs in Brazil

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CONFLICTS OF INTEREST
There are no conflicts of interest for any of the authors.

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ABSTRACT
Brazilian laws established regulatory limits in lettuce only to thermotolerant coliforms (fecal coliforms) and coagulase-positive *Staphylococci* of 10^2 MPN g^{-1} and 10^3 CFU g^{-1} respectively. The objective of this study was to evaluate and compare contamination of lettuce from conventional and organic cultivation, commercialized at fairs in south of Brazil, by the fecal coliforms, coagulase-positive *Staphylococci*, *Salmonella* spp. and *Listeria monocytogenes*. Eighty samples of traditionally and organically produced lettuce each were collected. The contaminated samples percent were 35 and 71.25, for fecal coliforms, 35 and 32,5 for coagulase-positive *Staphylococci*, 0 and 5 for *Salmonella* spp., 2.5 and 2.5 for *Listeria monocytogenes*, in conventional lettuce and organic lettuce, respectively. Results indicated that 35% of the samples of conventionally produced lettuce and 71.25% of the samples of organically produced one presented fecal coliform count above regulatory limits. Coagulase-positive *Staphylococci* counts above regulatory limits were verified in 28 and 26 samples from the conventional and organic agriculture, respectively. *Salmonella* spp. was present in 5% of organically produced samples and *L. monocytogenes* in 2.5% of lettuce samples from both types of agricultures. Obtained results highlight the importance of good practices from cultivation to commercialization to improve the hygienic-sanitary quality of vegetables.

Keywords: Vegetables, microorganisms, hygienic-sanitary quality

INTRODUCTION
Inclusion of vegetables in the daily diet is widely recommended due to their nutrient content, such as vitamins, minerals and dietary fiber, which are required for proper functioning of the human body [1, 2, 3]. Lettuce (*Lactuca sativa*) is among leafy vegetables popularly consumed in Brazil. This vegetable presents

nutritional benefits for consumers in addition to its low cost and availability [4, 5].

Despite many advantages, lettuce is one of the raw foods with the highest index of contamination, which may be related to failures in one of the stages of the production chain and hygienic-sanitary conditions of the manipulators [6, 7]. There are several factors among the production process that can contribute to the food susceptibility to contamination and make it a risk factor for human health. The vegetable contact with soil and organic residues in fertilizers, which depend on adopted cultivation system, can be a contamination factor [2, 8, 9].

Lettuce can be produced in the conventional, hydroponic and organic culture. In the conventional production system, vegetables are grown in soil with the appropriate application of water, nutrients and fertilizers [10]. Organic farming can be defined as a production system that excludes use of several pesticides, synthetic fertilizers, growth regulators or other contaminants [11].

Regardless of the adopted farming system, all vegetables must be produced following practices that result in products that are safe for human consumption [2]. However, improper manipulation during processing and distribution is a major cause of food-borne diseases [12, 13]. Microorganisms may represent risks to consumer's health. Vegetables consumed *in natura* are commonly associated with the presence of several species of microorganisms, among which are *Salmonella*, *Escherichia coli* and coliforms, of which the last two are indicators of hygienic-sanitary conditions in the production chain and *E. coli* and *coliforms* are indicators of pathogenic contamination of produce [9, 14, 15, 16, 17].

The consumption of raw vegetables is an important means of transmission of infectious and parasitic diseases in the population. Unfavorable sanitary conditions in rural and urban areas favor this contamination, transforming the vegetables into vehicles of transmission of pathogens, as fecal coliforms (in fecal coliforms group exist pathogenic species such as *E. coli*), coagulase-positive *Staphylococci*, *Salmonella* spp. and *Listeria monocytogenes*, causing public health risks.

In view of the above, the objective of this study was to evaluate and compare the contamination by fecal coliforms, coagulase-positive *Staphylococci*, *Salmonella* spp. and *Listeria monocytogenes* of lettuce from conventional and organic cultivation commercialized at fairs in in south of Brazil.

MATERIAL AND METHODS

Samples of conventionally (n=80) and organically (n=80) produced lettuce (*Lactuca sativa*), variety "American lettuce", were purchased at 20 local fairs in in south of Brazil, from January to December of 2016. At each purchase 4 samples of conventionally produced and 4 samples of organically produced lettuce were acquired, in total 20 purchases were made. The organic designation of lettuce is vendor reported and there is an organic fair certification by the city agriculture department.

Microbiological analysis was performed according to the methodology of the *American Public Health Association* (APHA), with modifications [18]. A total of 25 g (weight of sample) were aseptically weighted, identified and serially diluted down to 10^{-6}.

Fecal coliforms enumeration was done by the Most Probable Number (MPN) technique. The preliminary analysis of coliforms was carried out in Sodium Lauryl Sulphate Broth (SLS) after incubation at 35 ºC for 48 hours. The fecal coliforms enumeration was performed in *Escherichia coli* broth (EC) after incubation at 45.5 ºC for 24 hours. The results were expressed in MPN g^{-1}.

The isolation and quantification of *L. monocytogenes* were performed according to the methodology of the International Organization for Standardization, ISO 11.290-1 - Detection method [19], with modifications. The pre-enrichment stage was performed in Listeria Enrichment Broth (LEB) with incubation at 30ºC for 24 hours, followed by incubation of an aliquot in Fraser broth (supplemented with SR 0156E Oxoid®) at 35ºC for 48 hours. After that, seeding was performed in Oxford Agar (supplemented with SR 0140E Oxoid®) and Palcam Agar (supplemented with SR 0150E Oxoid®) followed by incubation at 35ºC for 48 hours. Purified isolates were submitted to phenotypic tests including determination of motility, carbohydrate fermentation capacity (dextrose, xylose, rhamnose and mannitol), and presence of catalase and β-hemolysin.

The isolation of *Salmonella* spp. was carried out after pre-enrichment in peptonated buffered water at 37 °C for 24 hours, selective enrichment in Rappaport-Vassiliadis Broth at 42 °C for 24 hours and Tetrathionate Broth at 37 °C for 24 hours. Seeding was performed on Deoxycholate-Lysine-Xylose (DLX) agar and Hektoen-Enteric (HE) agar plates, both incubated for 24 hours at 37 °C. Typical colonies were identified biochemically in Triple Sugar Iron Agar (TSI), Lysine Iron Agar (LIA) and Urease Agar at 37 °C for 24 hours. Isolates with characteristic biochemical reactions were submitted to serological identification using the polyvalent anti-somatic and flagellar *salmonella* sera (Probac).

The analysis of positive-coagulase *Staphylococci* was carried out by inoculation of 0.1 ml of each of serial dilutions, in Baird-Parker Agar using the surface seeding technique, in duplicate. Plates were incubated at 36 ± 1 °C for 24 to 48 hours. Colonies were enumerated and at least five colonies that presented typical morphology and five that presented atypical morphology were selected to perform the test of free coagulase

The likelihood ratio test for the ratio of the prevalence in organic versus conventional for fecal coliforms was used to determine if the prevalence of thermotolerant coliforms is significantly different.

RESULTS AND DISCUSSION

Results of determination of fecal coliforms, coagulase-positive *Staphylococci*, *Salmonella* spp. and *Listeria monocytogenes* in lettuce samples from conventional and organic cultivation are presented in Table 1.

Table 1- Quantification of thermotolerant coliforms, coagulase-positive staphylococci, *Salmonella* spp. and *Listeria monocytogenes* in samples from conventional (n=80) and organic (n=80) cultivation commercialized at fairs in south of Brazil, from January to December 2016. Percentage of contaminated samples relative to the total number of samples analyzed for each production system is shown in the parentheses.

Samples	Fecal coliforms * N (%)	Coagulase-positive *Staphylococci* ** N (%)	*Salmonella* spp. N (%)	*Listeria monocytogenes* N (%)
Conventional lettuce	28 (35)	28 (35)	0 (0)	2 (2.5)
Organic lettuce	57 (71.25)	26 (32.5)	4 (5)	2 (2.5)

N= number of contaminated samples; the number of samples with counts above the regulatory limits of 10^2 MPN g^{-1}* and 10^3 CFU g^{-1}**

There is a significant difference, in accord to likelihood ratio test for the ratio of the prevalence in organic versus conventional for thermotolerant coliforms, we get a risk ratio of 2.04 (95% CI 1.46, 2.80) with a p-value<0.001. According to microbiological standards established by the National Agency for Sanitary Surveillance (ANVISA) fresh, *in natura*, prepared (peeled, selected or fractionated), sanitized, refrigerated or frozen vegetables for direct consumption, may contain up to 10^2 microorganisms g^{-1} of food of fecal coliforms according to Resolution RDC No. 12, January 2001 [20]. Obtained results show that independently of the production system, fecal coliforms with cell count above 10^2 MPN.g.g^{-1} are present in lettuce. Presence of this microorganism was verified in 28 (35%) of the lettuce samples produced in conventional cultivation and in 57 (71.25%) of the lettuce samples produced in organic cultivation (Table 1). Barbosa et al. [3] reported the presence of fecal coliforms in 9 (60%) of 15 samples of conventionally produced lettuce. Coutinho et al. [21] investigated the microbiological quality of lettuce commercialized at open fairs and identified fecal coliform indexes above regulatory limits in all analyzed samples (n=12). In Brazil, different studies have demonstrated a high degree of contamination by fecal coliforms in vegetables during cultivation, which is associated with contamination of water used for irrigation [22, 23, 24, 25].

This fact could justify, in part, the high count of fecal coliforms in lettuce samples evaluated in this study. However, the greater contamination observed for samples from organic cultivation can be associated with the use of organic fertilizers such as fecal manure and also with inadequate hygienic-sanitary conditions during cultivation, handling, storage and transportation.

Salmonella spp. was not detected in any lettuce samples from the conventional cultivation, but it was found in 4 (5%) of the organically produced ones (Table 1). According to the Resolution RDC No. 12/2001 of ANVISA, *Salmonella* spp. must be absent in 25 g of fresh, chilled or frozen raw vegetables [20]. Food of animal origin is the main transmitter of *Salmonella* spp., however, several studies have reported the presence of this microorganism in products of plant origin as well [22, 26, 27]. Arbos et al. [2] identified the presence of *Salmonella* spp. in 1 (20%) lettuce sample from organic cultivation. Other studies reported the absence of *Salmonella* spp. in the analyzed lettuce samples, regardless of the place of origin or used production system [9, 28, 29]. According to Oliveira and Junqueira [30], the occurrence of *Salmonella* spp. in organic lettuce samples may be related to use of contaminated water for irrigation or bovine manure as fertilizer, influencing the final microbiological quality of the product.

According to the table 1, there was no difference between the number of lettuce samples from conventional and organic cultivation that had counts of coagulase-positive *Staphylococci* above 10^3 CFU g^{-1}. Therefore, 28 (35%) and 26 (32.5%) of the analyzed lettuce samples from conventional and organic cultivation, respectively, did not meet the microbiological standards established by the current legislation, which approves a tolerance of 10^3 $CFU.g^{-1}$ of food [20]. Trindade [31] reported the presence of coagulase-positive *Staphylococci* in 30% of lettuce salad samples analyzed, of which 21% were unsatisfactory or unacceptable for consumption. Monteiro [32] identified the presence of coagulase-positive *Staphylococci* in 22 out of 34 lettuce salad samples studied. Junqueira et al. [33] verified the presence of the pathogen in 32.2% of analyzed lettuce salads (n=31) from restaurants in Rio de Janeiro - RJ with count above 10^3 $CFU.g^{-1}$.The investigation of coagulase-positive *Staphylococci* in food is necessary since some of this microorganism strains can produce thermostable enterotoxins that are responsible for food poisoning with onset within few hours. Manipulators are believed to be the main source of contamination [34]. Therefore, the results obtained in this study are probably related to inadequate food handling, lack of correct hygiene, product storage at inappropriate temperature for long periods of time and, even may be associated with infected manipulators [31, 35].

The occurrence of *L. monocytogenes* was observed in 2 (2.5%) of lettuce samples from both type of production (Table 1). Brandão et al. [36] observed in their study of 97 samples of different types of vegetables the presence of *L. monocytogenes* in only 7 (7.2%) of the samples of vegetables *in natura* and salads. In recent studies, Vongkamjan et al. [37] and Scherer et al. [27] verified the presence of *Listeria* spp. in lettuces samples intended for direct consumption. Bergamo and Gandra [29] verified the presence of *Listeria* spp. in 10 lettuce samples (16.7%), of which 6 were from conventional, 2 from hydroponic and 2 from organic cultivation. This microorganism is part of an important class of human pathogens and, although there is no Brazilian legislation with reference values for it in fresh vegetables, it is widely distributed in the environment and in food. According to the *International Commission on Microbiological Specifications for Foods* [38], the cultivation stage is a primary contamination point by *L. monocytogenes* for leafy vegetables. Thus, the presence of *L. monocytogenes* in lettuce samples suggests their contamination during the production in the field by contaminated soil and/or water, and manipulators hands, or even in the sales establishments.

Several factors may influence the microbial hazards that affect food safety, which can be present at any point of the production chain, such as the growing, harvesting, washing, storage, transport, presentation, commercialization and finally, the consumer table [39, 40]. According to Pacheco et al. [41], the effectiveness of washing and disinfection procedures is essential for the elimination of pathogenic microorganisms present in plants, regardless of the culture system employed. As lettuce is usually consumed raw, in salads or sandwiches, contaminated can cause serious problems to consumer health and public health in a broader way, it is recommended to sanitize and sanitize with chlorine and subsequent rinse in water free of contaminants [42].

CONCLUSION

Lettuce samples from both conventional and organic cultivation sold at fairs in south of Brazil, were inadequate according to the established sanitary standard, which was evidenced by the presence of fecal coliforms, *Salmonella* spp., coagulase-positive *Staphylococci* and *L. monocytogenes*. Despite the absence of *Salmonella* spp. in lettuce samples from the conventional cultivation, hygienic-sanitary adjustment are necessary throughout the production chain in order to reduce the potential risks to consumers, contributing to the production of vegetables of good quality.

REFERENCES

1. Vongkamjan, K.; Fuangpaiboon, J.; Turner, M. P.; Vuddhakul, V. Various ready-to-eat products from retail stores linked to occurrence of diverse Listeria monocytogenes and Listeria spp. isolates. Journal of Food Protection, v. 79, n. 2, p. 239-245, 2016. PMid:26818984 View Article PubMed/NCBI
2. Sabbithi, A.; Kumar, R. N.; Kashinath, L.; Bhaskar, V.; Rao, S. V. Microbiological Quality of Salads Served along with Street Foods of Hyderabad, India. International Journal of Microbiology, v. 2014, p.6. 2014. PMid:24955092 View Article PubMed/NCBI
3. Brandão, M. L. L.; Bispo, F. C. P.; Almeida, D. O.; Rosas, C. O.; Bricio, S. M. L.; Marin, V. A. Listeria monocytogenes in green vegetables: isolation and serotyping. Revista do Instituto Adolfo Lutz, v. 72, n. 1, p. 116-121, 2013.
4. Costa, A. A.; Souza Júnior, V. M.; Santos, A. F. Avaliação microbiológica de saladas de vegetais servidas em restaurantes self service na cidade de Palmas, TO. Revista Higiene Alimentar, São Paulo, v. 22, n. 159, p. 27-32. 2008.
5. Junqueira, A. R.; Fleming, L. R.; Sampaio, L. S.; Nascimento, J. S. Estafilococos coagulase positiva em saladas de restaurantes self-service da cidade do Rio de Janeiro. Revista Perspectivas da Ciência e Tecnologia, Nilópolis, v. 1, n. 1, p. 1-10, 2009.
6. Monteiro, S.E.A. Avaliação da qualidade microbiológica de saladas prontas para consumo comercializadas na região de Lisboa. Dissertaçao (Mestrado em Tecnologia e Segurança Alimentar) – Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa. Lisboa, 2016.
7. Trindade, C. H. S. R. Avaliação da qualidade microbiológica de saladas preparadas em restauração pública. Dissertação (Mestrado em Segurança Alimentar e Saúde Pública) - Instituto Superior de Ciências da Saúde Egas Moniz. 2014.
8. Bergamo, G.; Gandra, E. Á. Avaliação microbiológica de alface cultivada sob as formas tradicional, orgânica e hidropônica. Brazilian Journal of Food Research, Campo Mourão, v. 7, n. 3, p. 82-93, set./dez. 2016.
9. Oliveira, I. M.; Junqueira, A. M. R. Aspectos da contaminação microbiológica em hortaliças. Brasília: UnB, 2005.
10. Bobco, S.E.; Pierozan, M.K.; Cansian, R.L.; Oliveira, D. de; Pinheiro, T.L.F.; Toniazzo, G. Condições higiênicas de alfaces (Lactuca sativa) comercializadas na cidade de Erechim - RS. Alimentos e Nutrição, v. 22, n.2, p. 301-305, 2011.
11. Scherer, K.; Granada, C. E.; Stülp, S.; SPerotto, R. A. Avaliação bacteriológica e físico-química de águas de irrigação, solo e alface (Lactuca sativa L.). Rev. Ambient. Água, Taubaté, v. 11, n. 3, p. 665 – 675, 2016.
12. Palú, A. P.; Tibana, A.; Teixeira, L. M.; Lemos, M. M. A.; Pyrrho, A. S.; Lopes, H. R. Avaliação microbiológica de frutas e hortaliças frescas, servidas em restaurantes self-service privados da Universidade Federal do Rio de Janeiro. Revista Higiene Alimentar, v. 16, p. 67-74, 2002.
13. Frittoli, R. B.; Rodrigues, L. H. Analysis of fecal coliform and Salmonella sp. in samples of minimally processed vegetables. Revista Científica da FHO-UNIARARAS, v. 2, n. 2, 2014.
14. Abreu, I. M. O.; Junqueira, A. M. R.; Peixoto, J. R.; Oliveira, S. S. Qualidade microbiológica e produtividade de alface sob adubação química e orgânica. Ciência e Tecnologia de Alimentos, Campinas, v. 30, n. 1, p. 108-118, May, 2010. View Article

15. Guimarães, A. M.; Alves, E. G. L.; Figueiredo, H. C. P.; Costa, G. M.; Rodrigues, L. S. Frequência de enteroparasitas em amostra de alface (Lactuca sativa) comercializada em Lavras, Minas Gerais. Revista da Sociedade Brasileira de Medicina Tropical, v. 36, n. 5, p. 621-623, 2003. PMid:14576879 View Article PubMed/NCBI
16. Takayanagui, O. M.; Febrônio, L. H. P.; Bergamini, A. M.; Okino, M. H. T.; Castro e Silva, A. A. M. C.; Santiago, R.; Capuano, D. M.; Oliveira, M. A.; Takayanagui, M. M. Fiscalização de hortas produtoras de verduras do município de Ribeirão Preto, SP. Revista da Sociedade Brasileira de Medicina Tropical, v. 33, n. 2, p. 169-174, 2000. PMid:10881129 View Article PubMed/NCBI
17. Coutinho, M. G. S.; Ferreira, C. S.; Neves, A. M.; Alves, F. R. L.; Souza, F. F. P.; Fontenelle, R. O. Dos Santos. Avaliação microbiológica e parasitológica de alfaces (Lactuca sativa L) comercializadas em feiras livres no município de Sobral – CE. Revista da Universidade Vale do Rio Verde, v. 13, p. 388-397. 2015.
18. Brasil. Ministério da Saúde. Agência Nacional de Vigilância Sanitária. Resolução RDC nº. 12, de 02 de Janeiro de 2001. Aprova o regulamento técnico sobre padrões microbiológicos para alimentos. Diário Oficial da República Federativa do Brasil, Brasília, 02 de jan. 2001.
19. International Organization for Standardization (ISO). Microbiology of food and animal feeding stuffs – Horizontal method for the detection and enumeration of Listeria monocytogenes – Part 1: Detection method, International Standard ISO 11290-1, Geneva, Switzerland, 1996.
20. Okura, M. H.; Mariano, A. M. S. E.; Teixeira, A. N. S. Eficiência de sanitizantes no tratamento "minimamente processado" de alface cultivada em meio hidropônico. Revista Higiene Alimentar. São Paulo, v. 20, n. 142, jul. 2006.
21. Downes, F. P.; Ito, H. Compendium of methods for the microbiological examination of foods. 4. ed. Washington: American Public Health Association (APHA), 676 p. 2001.
22. Nascimento, A. R.; Mouchrek Filho, J. E.; Mouchrek Filho, V. E.; Martins, A. G. De A. L.; Bayma, A. B.; Gomes, S. V.; Marinho, S. C.; Carvalho, P. A. B.; Garcias Junior, A. V. Incidência de Escherichia coli e Salmonella em alface (Lactuca sativa). Revista Higiene Alimentar, v. 19, n. 131, p. 223-225, 2005.
23. Maistro, L.C. Alface minimamente processada: uma revisão. Revista de Nutrição, v.14, n.3, p.219-224, 2001. View Article
24. Santos, T.B. A. dos et al. Condições higiênico-sanitárias de alfaces antes e após tratamento com agente antibacteriano. Revista Higiene Alimentar. São Paulo, v. 18, n. 121, jun. 2004.
25. Neres, A. C.; Nascimento, A. H.; Lemos, K. R. M.; Ribeiro, E. L.; Leitão, V. O.; Pacheco, J. B. P.; Diniz, D. O.; Aversi-Ferreira RAgmf, R.; Aversi-Ferreira, T. L. Enteroparasitos em amostras de Alface (Lactuca sativa var.crispa), no município de Anápolis, Goiás, Brasil. Bioscience. Journal, v. 27, p. 336-341, 2011.
26. Rodrigues, C.S. Contaminação microbiológica em alface e couve comercializadas no varejo de Brasília-DF. [Trabalho de conclusão de curso]. Brasília (DF): Universidade de Brasília; 2007.
27. Hamerschmidt, I. Agricultura orgânica: conceituações e princípios. In: Anais do 38º Congresso Brasileiro de Olericultura. Petrolina (PE): ART & MÍDIA, 1998. cd-rom.
28. Stertz, S. C.; Penteado, P. T. P. S.; Freitas, R. J. S. Nitritos e nitratos em hortícolas produzidas pelos sistemas de cultivo convencional orgânico e hidropônico na Região Metropolitana de Curitiba. Revista do Instituto Adolfo Lutz, v. 63, n. 2, p. 200-207, 2004.
29. Santana, L.R.R.; Carvalho, R.D.S.; Leite, C.C.; Alcântara, L.M.; Oliveira, T.W.S.; Rodrigues, B.M. Qualidade física, microbiológica e parasitológica de alfaces (lactuca sativa) de diferentes sistemas de cultivo. Ciênc. Tecnol. Aliment., Campinas, v. 26 n. 2, 264-269. 2006.
30. Beuchat, L. R. Ecological factors influencing survival and growth of human pathogens on row fruits and vegetables. Microbes and Infection, v. 4, n. 4, p. 413-423, apr. 2002. 01555-1 View Article
31. Mogharbel, A. D. I.; Masson, M. L. Perigos asso-

ciados ao consumo da alface, (Lactuca sativa), in natura. Alimentos e Nutrição, Araraquara, v. 16, n. 1, p. 83-88, jan-mar, 2005.
32. Traviezo-Valles, L.; D'ávila, J.; Rodríguez, R.; Perdomo, O.; Pérez, J. Contaminación enteroparasitaria de lechugas expendidas en mercados del estado Lara. Parasitologia Latinoamericana, Santiago, v. 59, p. 167-170, 2004. View Article
33. Silva, E. M. N. C. P., Ferreira, R. L. F.; Araújo Neto, S. E.; Tavella, L. B.; Solino, A. J. S. Qualidade de alface crespa cultivada em sistema orgânico, convencional e hidropônico. Horticultura Brasileira, Brasília, v. 29, n. 2, abr-jun, 2011.
34. Montanher, C. C.; Coradin, D. De Camargo.; Fontoura-da-Silva, S. E. Avaliação parasitológica em alfaces (Lactuca sativa) comercializadas em restaurants self-service por quilo, da cidade de Curitiba, Paraná, Brasil. Estudos de Biologia: Ambiente e Diversidade, v. 29, n. 66, p. 63-71, jan-mar, 2007. View Article
35. Barbosa, V. A. A.; Filho, F. C. C.; Da Silva, A. X. L.; Oliveira, G. S.; De Albuquerque, W. F.; Barros, V. C. Comparison of lettuce (Lactuca sativa) contamination from two types of farming. Brazilian Journal of Hygiene and Animal Sanity, v. 10, n. 2, p. 231-242, Abr-Jun, 2016. View Article
36. Arbos, K. A.; Freitas, R. J. S; Stertz, S. C.; Carvalho, L. A. Segurança alimentar em hortaliças orgânicas: aspectos sanitários e nutricionais. Ciência e Tecnologia de Alimentos, Campinas, v. 30, v. 1, p. 215- 220, maio, 2010.
37. Fernandes, A. A.; Martinez, H. E. P.; Pereira, P. R. G.; Fonseca, M. C. M. Produtividade, acúmulo de nitrato e estado nutricional de cultivares de alface, em hidropônia, em função de fontes de nutrientes. Horticultura Brasileira, Brasília, v. 20, n. 2, p. 195-200, 2002. View Article
38. International Commission on Microbiological Specifications for Foods. El sistema de analisis de riesgos y puntos críticos - Su aplicación a las industria de alimentos. Zaragoza: Acribia, 1991, 332p.
39. Costantin, B.D.S.; Gelatti, L.C.; Dos Santos, O. Avaliação da contaminação parasitológica em alfaces: Um estudo no sul do Brasil. Revista Fasem Ciências, v. 3, n. 1, p. 1-14, Jan-Jun, 2013.
40. Ranthum, M.A. Subnotificação e alta incidência de doenças veiculadas por alimentos e seus fatores de risco: causas e consequências no município de Ponta Grossa-PR. [dissertação de mestrado]. Rio de Janeiro (RJ): Escola Nacional de Saúde Pública; 2002.
41. Pacheco, M.A.S.R.; Fonseca, Y.S.K.; Dias, H.G.G.; Cândido, V.L.P.; Gomes, A.H.S.; Armelin, I.M. Condições higiênico-sanitárias de verduras e legumes comercializados no CEAGESP de Sorocaba- SP. Revista Higiene Alimentar, v. 16, n. 101, p. 50-5, 2002.
42. Abreu, I.M.O.; Junqueira, A.M.R.; Peixoto, J.R.; Oliveira, S.A. Qualidade microbiológica e produtividade de alface sob adubação química e orgânica. Ciência e Tecnologia de Alimentos, v. 30, n. 1, p. 108-118, 2010. View Article

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