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DEHYDRATED SHRIMP: A BIBLIOMETRIC STUDY

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ABSTRACT

The objective of the work was to carry out a bibliometric study of dehydrated shrimp. Scopus database was used for the search during 1980-2021. Documents were classified by year, author, journal, affiliation, country, type of document, and study area. The research showed sixty-eight documents, mostly from last five years, and usually scientific articles. China, Thailand and Iran stand out as leading countries. Hot air drying has been the most used technique found in dehydrated shrimp studies.
Palabras clave: shrimp, *Penaeus vannamei*, drying, bibliometric study.

RESUMEN

Camarón deshidratado: un estudio bibliométrico

El objetivo del trabajo fue realizar un estudio bibliométrico del camarón deshidratado. Para la búsqueda durante el período 1980-2021 se utilizó la base de datos Scopus. Los documentos se clasificaron por año, autor, revista, afiliación, país, tipo de documento y área de estudio. La búsqueda mostró 68 documentos, la mayoría de los últimos cinco años y artículos científicos principalmente. China, Tailandia e Irán destacaron como países líderes. El secado en estufa ha sido la técnica más usada en los estudios de camarón deshidratado.
Keywords: camarón, *Penaeus vannamei*, secado, estudio bibliométrico.

INTRODUCTION

Shrimp (*Penaeus vannamei*) is one of the most consumed marine products because its high nutritional and economic value. It represents a good source of high-quality proteins (20% of wet basis) with an adequate balance of amino acids, functional lipids (10,7% of dry basis), as well as long-chain polyunsaturated fatty acids, especially eicosapentaenoic acid and docosahexaenoic acid (*1*, *2*).

However, shrimp is highly perishable and it has a short shelf life (*3*). To solve this problem, preservation technologies have been applied, including dehydration (*3-11*). The production of dried shrimp is an inexpensive and convenient processing that consists of two steps: boiling and drying. Boiling shrimp in a salt solution can inhibit the enzyme activity and reduce the microbial count. Drying is an essential process in which the moisture content of shrimp gradually decreases by 57,14%. Values have been informed between 6 and 15% of moisture content for conventional methods and even between 1 and 4% for innovative methods (*3*, *10*, *11*). Several methods of physical drying have been developed for fish and fish products including hot air oven drying (HAD), combination of solar energy and mechanical drying, smoke drying, freeze drying (FD), vacuum drying, fluidized bed drying, spray drying (*12*).

This process results in a series of quality changes, including those in texture, color and flavor. It is considered a simple method that allows the storage of shrimp at room temperature and reduces its transportation costs (*2*). Additionally, dehydrated shrimp is highly coveted for the distinctive aroma that develops during the heat process. N-containing heterocycles, trimethylamine, S-containing compounds and common carbonyl compounds have been reported as contributors to the aroma of dehydrated shrimp (*13*).

From the set of scientific information bases, such as Google Scholar, Scopus, Web of Sciences, ScienceDirect, SciFinder, Chemical Abstract and Food Science and Technology Abstracts, Scopus stands out for being the most popular in most scientific institutions and universities due to the high quality it provides to research (*14*). Therefore, Scopus base was selected to analyze the documents about dehydrated shrimp during 1980-2021. The search was done with the keywords 'shrimp dehydration' or 'shrimp drying' in the title, abstract or keywords of the documents cited. The objective of the work was to carry out a bibliometric study of shrimp dehydration. Documents were classified by year, author, journal, affiliation, country, type of document, and study area.

RESULTS AND DISCUSSION

The research showed sixty-eight documents between 1980-2021. The most prolific year was 2021 with ten documents (Fig. 1). Also, last five years represent almost the half of the total documents. These documents were mainly distributed in articles, conference papers, book chapters and conference reviews as it shows Fig. 2. The higher mount of articles was published in Drying Technology, Nongye Gongcheng Xuebao/Transactions of the Chinese Society of Agricultural Engineering, and Journal of Food Engineering (Fig. 3).

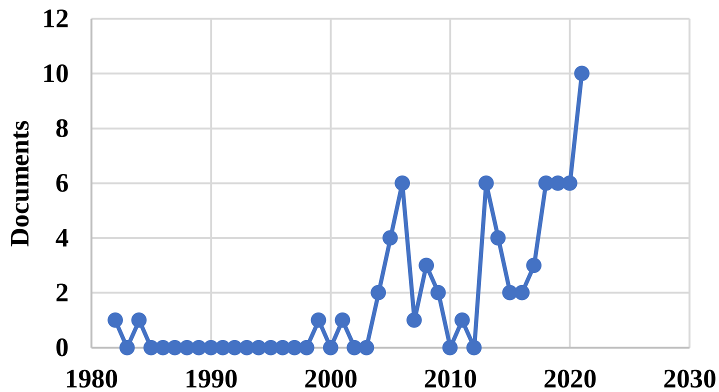

Fig. 1. Dehydrated shrimp studies by year.

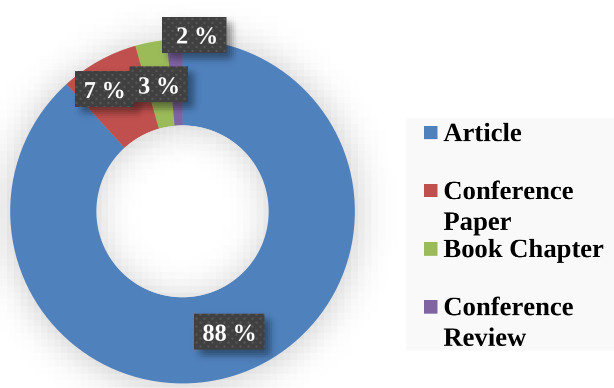

Fig. 2. Dehydrated shrimp studies by document type.

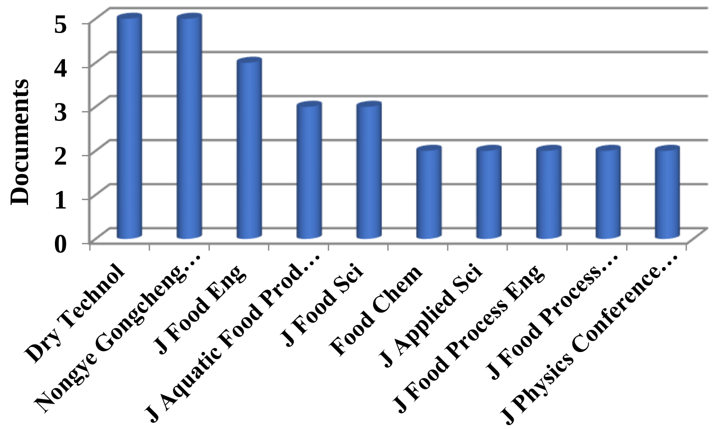

Fig. 3. Dehydrated shrimp studies by journal source.

Fig. 4 shows the most productive authors in this subject: Thais S. Devahastin and S. Soponronnarit, and Iranian M. Mohebbi. China, Thailand and Iran stand out as leading countries with sixteen, ten and nine documents, respectively (Fig. 5). One-hundred-twenty-seven affiliations have been part of dehydrated shrimp researches, particularly, King Mongkut's University of Technology Thonburi from Thailand, and Dalian Ocean University from China (Fig. 6). Several institutions have sponsored these studies, ministries, research centers and universities, in particular, the Ministry of Science and Technology of the People's Republic of China stands out with four contributions (Fig. 7).

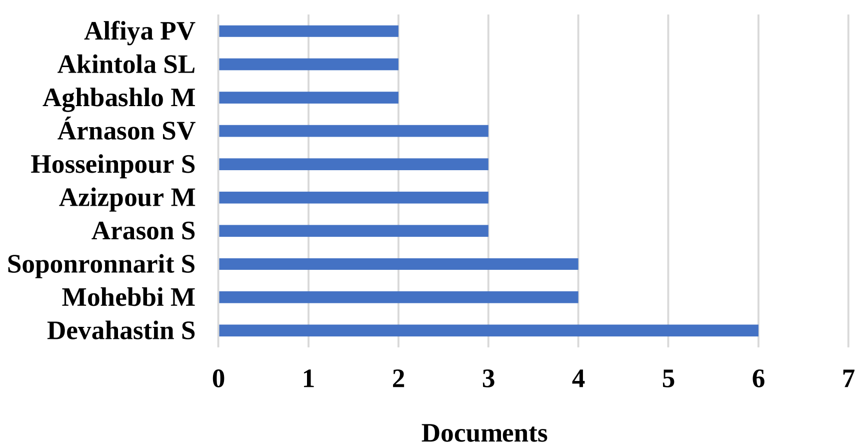

Fig. 4. Dehydrated shrimp studies by author.

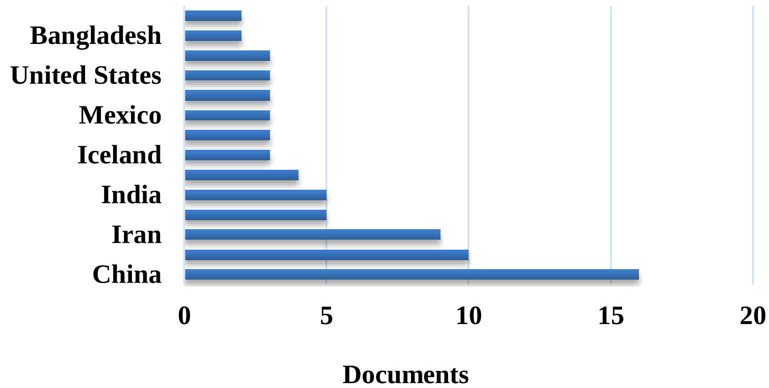

Fig. 5. Dehydrated shrimp studies by country.

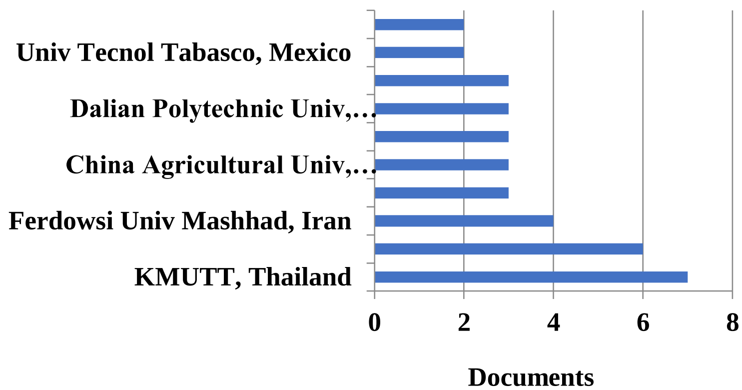

Fig. 6. Dehydrated shrimp studies by affiliation.

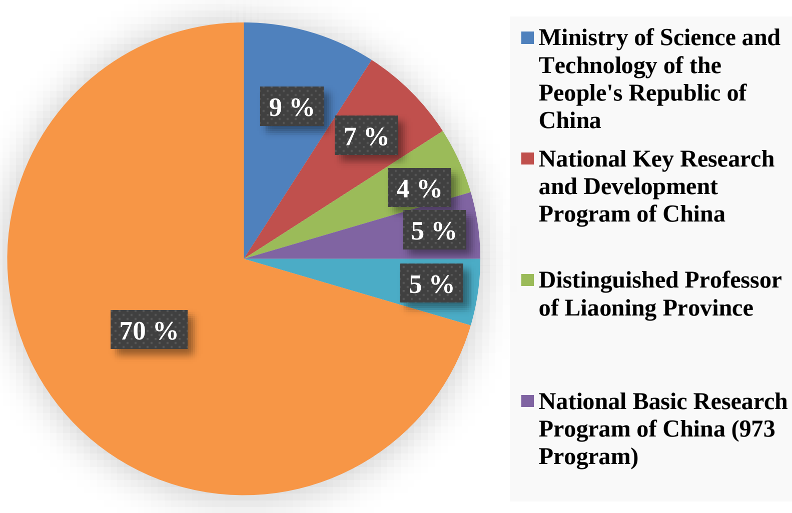

Fig. 7. Dehydrated shrimp studies by funding sponsor.

Finally, Fig. 8 resumes the documents by subject area, in which Agricultural and Biological Sciences, Engineering, Chemical Engineering and Chemistry were frequently areas, but the first one excelled with forty-six documents.

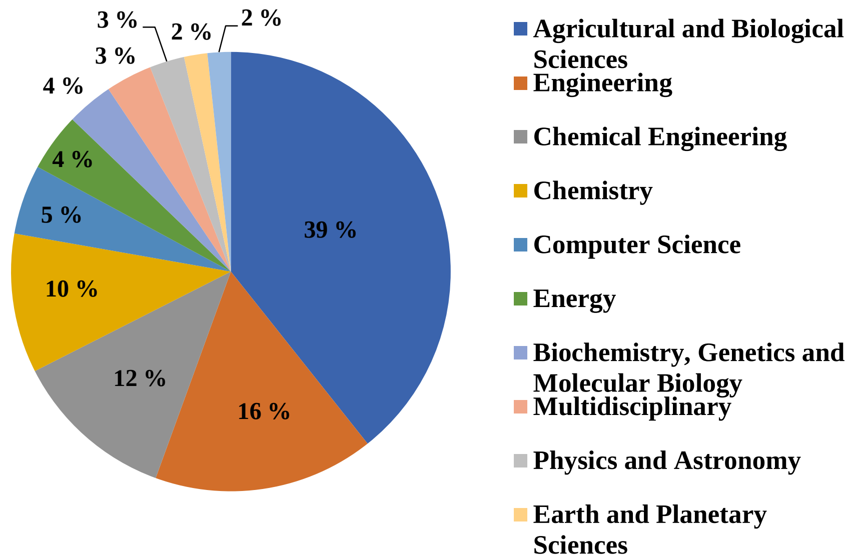

Fig. 8. Dehydrated shrimp studies by subject area.

Table 1 shows several drying methods used in shrimp drying. HAD represents the most studied technique found in the search. This is the widely accepted drying method in the seafood industry as it is easy to implement, less costly and simple to operate and maintain. However, this technique has a few drawbacks that it involves more energy consumption and long drying period resulting in products of inferior quality (*12*). For these reasons, HAD has been combined with others drying techniques. The combination of HAD and FD for drying shrimp resulted in a product with lower shrinkage, higher rehydration rate and better sensory qualities (*15*).

Method	Reference
Conventional sun drying	*16, 17*
Freeze drying	*10, 11, 15, 18*
Heat pump drying	*19-21*
Hot air drying	*2, 3, 10, 11, 13, 15, 20, 22-31*
Hot smoking	*16*
Hybrid infrared radiation	*24*
Jet spouted bed drying	*32, 33*
Solar drying	*24, 28, 34*
Spray drying	*35*
Superheated steam drying	*20, 22, 25-27*
Vacuum drying	*23*

The drying of shrimp had been evaluated using a superheated steam dryer followed by a heat pump (SSD/HPD) or a HAD (SSD/HAD) (*20*). The results showed that SSD/HPD dried shrimp had much lower degree of shrinkage, higher degree of rehydration, better color, less tough and softer, and more porous than single-stage SSD dried shrimp. It was also found that SSD/HAD gave redder shrimp compared to shrimp dried in a single-stage superheated steam dryer. In other study, it was found that the color characteristic of the SSD finished shrimp products were more acceptable than HAD processed samples (*26*).

As a conventional drying method, HAD may lead to loss of nutrients, bad taste and deep color in products. However, FD can preserve nutritional quality and color of foods due to being carried out under vacuum and low temperature (*11*). These authors found that FD caused less lipid oxidation compared to HAD, caused to the lower levels of primary and secondary oxidation products, as well as acid value, and higher contents of eicosapentaenoic acid and docosahexaenoic acid in freeze dried samples.

The drying parameters vary according to the method, so it has been found studies with drying conditions of 90 ˚C for 4 h (*2*), 50 ˚C for 22 h (*10*), 85 ˚C for 7 h (*13*), and 60 ˚C for 20 h (*11*), 3 h (*30*) and 6 h (*31*); all of these experiments for HAD. In the other hand, it has been reported FD conditions of 35 ˚C for 3 h (*10*) and 40 ˚C for 4 h (*11*).
In the case of aroma, researchers informed that aroma characteristic of shrimps changed significantly during processing. The aroma characteristics mainly consisted of roasted and meat-like odors had come into being gradually

with the decrease of water activity (Aw). The most desirable aroma was obtained at about Aw 0,274 (drying for 7 h). Four kinds of aroma-active compounds (pyrazines, amines, aldehydes and heterocyclic compounds) made important contributions to the formation of aroma characteristics (*13*).

Authors reported 2-ethyl-5-methyl-pyrazine, octanal, trimethylamine, 1-octene-3-ol and hexanal were the most potent odorants in hot air-dried shrimp. In boiled shrimp, 1-octene-3-ol, octanal and hexanal were identified as aroma-active compounds, while trimethylamine and pyrazines were mainly produced during the drying stage (*2*).

CONCLUSIONS

The research showed sixty-eight documents in relation to shrimp drying, mostly from last five years, and usually scientific articles. China, Thailand and Iran stand out as leading countries of this subject area. Hot air drying has been the most used technique found in dehydrated shrimp studies. However, this method usually it combined with other methods for supply its drawbacks.

REFERENCES

1. De-Yang L, Da-Yong Z, Fa-Wen Y, Xiu-Ping D, Hong-Kai X, Zhong-Yuan L, Ao L. Impact of different drying processes on the lipid deterioration and color characteristics of *Penaeus vannamei*. J Sci Food Agric 2020; 100:2544-53.
2. Hu M, Wang S, Liu Q, Cao R, Xue Y. Flavor profile of dried shrimp at different processing stages. LWT - Food Sci Technol 2021; 146:e111403. DOI: 10.1016/j.lwt.2021.111403
3. Castañeda-López GG, Ulloa JA, Rosas-Ulloa P, Ramírez-Ramírez JC, Gutiérrez-Leyva R, Silva-Carrillo Y, Ulloa-Rangel BE. Ultrasound use as a pretreatment for shrimp (*Litopenaeus vannamei*) dehydration and its effect on physicochemical, microbiological, structural, and rehydration properties. J Food Process Preserv 2021; 45(4):e15366. DOI: 10.1111/jfpp.15366
4. Zarei H, Nikoo M, Rahmanifarah K. Effect of boiling in salt solution and drying on the quality of farmed Pacific white shrimp (*Litopenaeus vannamei*). J Food Sci Technol 2021; 18(115):203-11.
5. Binalshikh-Abubkr T, Hanafiah MM, Das SK. Proximate chemical composition of dried shrimp and tilapia waste bioflocs produced by two drying methods. J Mar Sci Eng 2021; 9(2):1-16.
6. Narsaiah K, Bedi V, Ghodki BM, Goswami TK. Heat transfer modeling of shrimp in tunnel type individual quick freezing system. J Food Process Eng 2021; DOI: 10.1111/jfpe.13838
7. Martins TS, Sousa TSE, Sales VHG, Gloria M da, Higuita DMC, Vélez HAV. Comparison between thin-layer models and non- traditional methods in the modelling of drying kinetics of crustacean wastes. Brazilian Archives Biol Technol 2021; 64:1-15.
8. Hosseinpour S, Martynenko A. Food quality evaluation in drying: Structuring of measurable food attributes into multi-dimensional fuzzy sets. Dry Technol 2021; DOI: 10.1080/07373937.2021.1933514
9. Murali S, Delfiya DSA, Kumar KS, Kumar LRG, Nilavan SE, Amulya PR, Krishnan VS. Mathematical modeling of drying kinetics and quality characteristics of shrimps dried under a solar–LPG hybrid dryer. J Aquatic Food Product Technol 2021; 30(5):561-78.
10. Ling JG, Xuan XT, Yu N, Cui Y, Shang HT, Liao XJ, Lin XD. High pressure-assisted vacuum-freeze drying: A novel, efficient way to accelerate moisture migration in shrimp processing. J Food Sci 2020; 85(4):1167-76.
11. Li DY, Zhou DY, Yin FW, Dong XP, Xie HK, Liu ZY, Li A, Li JX. Impact of different drying processes on the lipid deterioration and color characteristics of *Penaeus vannamei*. J Sci Food Agric 2020; 100(6):2544-53.
12. Viji P, Shanmuka-Sai KS, Debbarma J, Dhiju Das PH, Madhusudana-Rao B, Ravishankar CN. Evaluation of physicochemical characteristics of microwave vacuum dried mackerel and inhibition of oxidation by essential oils. J Food Sci Technol 2019; DOI: 10.1007/s13197-019-03651-7.
13. Zhang D, Ji HW, Luo GX, Chen H, Liu SC, Mao WJ. Insight into aroma attributes change during the hot-air-drying process of white shrimp using GC-MS, E-Nose and sensory analysis. Food Sci Technol 2022; 42. DOI: 10.1590/fst.70820
14. Pino JA. Tendencias en las publicaciones en relación con el aroma del banano 1963-2019. Cienc Tecnol Aliment 2020; 30(1):60-8.
15. Bai Y, Hu Y, Huang Q. Study on a Combination Drying Technique of shrimp. Appl Mech Mater 2013; 260-261:804-7.
16. Akintola SL, Brown A, Bakare A, Osowo OD, Bello BO. Effects of hot smoking and sun drying processes on nutritional composition of giant tiger shrimp (*Penaeus monodon* F.). Pol J Food Nutr Sci 2013; 63(4):227-37.
17. Hernández-Becerra JA, Ochoa-Flores AA, Valerio-Alfaro G, Soto-Rodriguez I, Rodríguez-Estrada MT, García HS. Cholesterol oxidation and astaxanthin degradation in shrimp during sun drying and storage. Food Chem 2014; 145:832-9.
18. Donsì G, Ferrari G, Di Matteo P. Utilization of combined processes in freeze-drying of shrimps. Trans IChemE 2001; 79:152-9.
19. Chua KJ, Hawlader MNA, Chou SK, Ho JC. On the study of time-varying temperature drying-Effect on drying

kinetics and product quality. Dry Process 2002; 20(8):1559-77.
20. Namsanguan Y, Tia W, Devahastin S, Soponronnarit S. Drying kinetics and quality of shrimp undergoing different two-stage. Dry Process 2004; 22(4):759-78.
21. Guochen Z, Arason S, Árnason SV. Dehydration property of shrimp (*Pandalus borealis*) undergoing heat-pump drying process. Int J Agric Biol Eng 2009; 2(4):92-7.
22. Prachayawarakorn S, Somchart Soponronnarit S, Wetchacama S, Jaisut D. Desorption isotherms and drying characteristics of shrimp in superheated steam and hot air. Dry Technol 2002; 20(3):669-684.
23. Tiong NK, Soon EY, Woan PL, How KL, Guat TA. Innovative techniques for traditional dried fish products. En: Sakaguchi M, Ed. More Efficient Utilization of Fish and Fisheries Products. Amsterdam: Elsevier Publishing; 2004. pp 397-406.
24. Tirawanichakul S, Na Phatthalung W, Tirawanichakul Y. Drying strategy of shrimp using hot air convection and hybrid infrared radiation/hot air convection. Walailak J Sci Tech 2008; 5(1): 77-100.
25. Hosseinpour S, Rafiee S, Mohtasebi SS. Application of image processing to analyze shrinkage and shape changes of shrimp batch during drying. Dry Technol 2011; 29:1416-38.
26. Hosseinpour S, Rafiee S, Mohtasebi SS, Aghbashlo M. Application of computer vision technique for on-line monitoring of shrimp color changes during drying. J Food Eng 2013; 115:99-114.
27. Hosseinpour S, Rafiee S, Aghbashlo M, Mohtasebi SS. A novel image processing approach for in-line monitoring of visual texture during shrimp drying. J Food Engin 2014; 143:154-66.
28. Akonor PT, Ofori H, Dziedzoave NT, Korte NK. Drying characteristics and physical and nutritional properties of shrimp meat as affected by different traditional drying techniques. Int J Food Sci 2016. DOI: 10.1155/2016/7879097
29. Costa MV da, Silva AKN da, Rodrigues P, Meller-da Silva LH, Cruz-Rodrigues AM da. Prediction of moisture transfer parameters for convective drying of shrimp at different pretreatments. Food Sci Technol 2018; 38(4). DOI: 10.1590/fst.31517
30. Wisaiprom N, Kadsayapanand N, Palasai W. The comparative study of shrimp drying process with low humidity air and hot air drying. Princess Naradhiwas Univ J 2018; 11(1):83-94.
31. Nguyen MP, Ngoa TT, Le TD. Experimental and numerical investigation of transport phenomena and kinetics for convective shrimp drying. C Stud Therm Eng 2019; 14:e100465. DOI: 10.1016/j.csite.2019.100465
32. Devahastin S, Tapaneyasin R, Tansakul A. Hydrodynamic behavior of a jet spouted bed of shrimp. J Food Engin 2006; 74:345-51.
33. Niamnuy C, Devahastin S, Soponronnarit S, Raghavan GSV. Modeling coupled transport phenomena and mechanical deformation of shrimp during drying in a jet spouted bed dryer. Chem Engin Sci 2008; 63:5503-12.
34. Murali S, Amulya PR, Alfiya PV, Aniesrani-Delfiya DS, Manoj PS. Design and performance evaluation of solar - lpg hybrid dryer for drying of shrimps. Renew Energy 2020; 147(1):2417-28.
35. Paula-da Costa J de, Moura-Neto LG de, Rodrigues S, Correia-da Costa JM. Assessing the use of arabic gum as a drying adjuvant for powdered shrimp obtained using a spray dryer. Cienc Anim Bras 2020; 21:e56666. DOI: 10.1590/1809-6891v21e-56666