

# REVIEW OF JOURNALS WITH A PARTICULAR EMPHASIS ON PAPERS IN WHICH SORPTION ISOTHERMS WERE DETERMINED

## PREGLED ČASOPISA SA POSEBNIM AKCENTOM NA RADOVE U KOJIMA SU ODREĐIVANE IZOTERME SORPCIJE

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### ABSTRACT

The main idea of this paper is to review and present the papers in which sorption isotherms of different types of materials were determined. For this purpose, the number of publications, references, etc., in the most frequently used journals for publications of sorption isotherms papers were studied. In order to obtain clear picture what is realistic to expect from the scientific investigation in fields of determination of sorption isotherms for different materials in the near future and where future research should be focused, some statistical analysis were made. The papers have been classified into nine categories: I. Papers in which determination of sorption isotherms of fruits are performed; II. Vegetables; III. Tea, Herbs, Coffee and Tobacco; IV. Pistachio nuts, Almond, Soybeans and Cereals; V. Flour, Pasta and Powder milk; VI. Meat and Fish; VII. Foodstuffs; VIII. Wood, Paper and Clay and IX. Pharmaceutical materials. From the performed analysis it was concluded that the categories of papers 'Foodstuffs', 'Fruits', 'Pistachio nuts, Almond, Soybean and Cereals', 'Vegetables' and 'Flour, Pasta and Powder milk' comprise 75.6% of the published referent papers. The remaining categories of papers for 'Tea, Herbs, Coffee and Tobacco', 'Meat and Fish', 'Wood, Paper and Clay' and 'Pharmaceutical materials', are 24.4% of the referent papers. For this reason, future research should be focused of determination of sorption isotherms of these materials.

**Key words:** review, journals, sorption isotherms.

### REZIME

Osnovna ideja ovog rada je pregled i prikazivanje radova u kojima su određivane izoterme sorpcije različitih vrsta materijala. U tu svrhu proučavan je određen broj publikacija, reference itd. u relevantnim časopisima gde su objavljeni radovi sorpcionih izoterma. Da bi se dobila jasna slika o tome šta se može realno očekivati iz naučnih istraživanja na polju određivanja sorpcionih izoterma različitih materijala u bliskoj budućnosti i u kom pravcu treba da budu usmerena idna istraživanja, izvršene su statističke analize. Za statističku obradu podataka radovi su klasificirani u devet kategorija: I. radovi u kojima su određivane izoterme sorpcije voća, II. povrća, III. čaj, lekovito bilje, kafa i duvan, IV. f'stake, bademi, lešnjaci, soja i žitarice, V. praškasti materijali, VI. meso i riba, VII. prehrambenih materijali, VIII drvo, hartija i glina, IX. farmaceutski materijali. Izvršene analize ukazuju da radovi iz grupa 'prehrambenih materijala', 'voće', 'f'stake, bademi, lešnjaci, soja i žitarke', 'povrće' i 'praškasti materijali', čine 75.6% od objavljenih referentnih radova. Pomenute kategorije radova iz grupe 'čaj, lekovito bilje, kafa i duvan', 'meso i riba', 'drvo, hartija i glina' i 'farmaceutski materijali', čine 24.4% referentnih radova. Iz ovih razloga, buduća istraživanja trebalo bi da budu fokusirana na određivanje sorpcionih izoterma ovih materijala.

**Ključne reči:** pregled, časopisi, izoterme sorpcije.

### INTRODUCTION

Sorption isotherms are important tool for the solution of engineering problems. The knowledge of sorption isotherms is important in food science and technology for microbiological, enzymatic and chemical stability of the materials. They are used in the design and optimization of drying equipment, design of packages, predictions of quality, stability, shelf - life and for calculating moisture changes that may occur during storage.

In order to obtain a clear picture for the trend on published papers in which were determined sorption isotherms on different materials, surveys in eight relevant journals were made. As follows:

1. Drying Technology-An International Journal-DT
2. Food Research International-FRI
3. International Journal of Food Properties-IJFP
4. Journal of Food Process Engineering-JFPE
5. Food and Bioproducts Processing-FBP
6. International Journal of Food Science&Technology-IJFST

7. Journal of Food Engineering-JFE
8. LWT Food Science and Technology-LWT FST.

The researches conducted in the papers published in these journals should answer the following questions:

Which trends can be deduced from the advances in published papers and references' publications in past years?

What is realistic to expect from the scientific investigation in these fields in the near future?

In which direction future research in this field should be focused?

### Some historical data

Easy access to electronic database on editions of each journal makes it possible nowadays to find data on history of papers in which sorption isotherms were determined. Each journal has begun with electronic issue from a different year. The electronic issue from 1966 for the International Journal of Food Science

and Technology is the oldest, while the issue from 1998 for the International Journal of Food Properties is with the latest date.

The results of the surveys from eight journals (total number of papers and papers in which sorption isotherms were determined, i.e. so-called reference papers) are shown on figure 1.

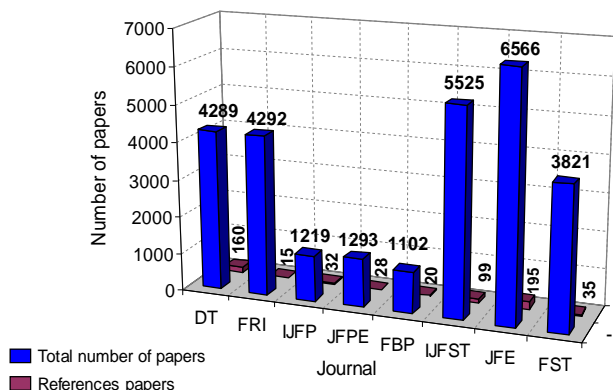


Fig. 1. Publications in most frequently used journals

It may be noted that the number of papers in which sorption isotherms are determination is quite different and low in comparison with total number of published papers. The highest percentage is about 3.73% in Drying Technology-An International Journal and the lowest is 0.35% in Food Research International. The reasons are probably of different nature. It depends on the character of the journal, topics, aim and scope, etc. Beside the determination of sorption isotherms, the papers in these journals deal with other topics like heat and mass transfer in multiphase systems, transport phenomena in porous media, measurement methods, data of food properties, engineering properties of foods etc. From figure 2 to figure 9 chronologically are shown the total numbers of papers and reference papers for each journal separately. Of the total number of published papers (4289) in Drying Technology-An International Journal, 160 papers i.e. 3.73% refer to determination of sorption isotherms.

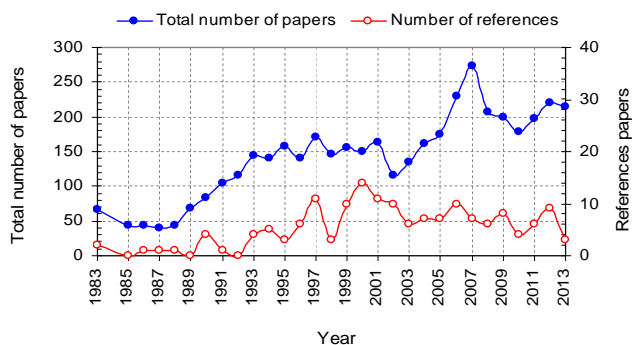


Fig. 2. Evolution of papers and references in Drying Technology -An International Journal

From Figure 2, it can be observed that from 1983 to 1995 the number of published papers in which sorption isotherms were determined is insignificant, while from 1996 to 2012 the number of papers is significant, excluding 1998 and 2010 (when 3 and 4 references papers were published). There is dramatic decrease in the published reference papers in the year 2013 - only 3.

Food Research International is an official journal of the Canadian Institute of Food Science and Technology. In this journal from 1992 to 2013, 4292 papers were published, but only 15 papers (i.e. 0.35%) refer to determination of sorption isotherms. From Figure 3 it is obvious that the number of published reference papers is insignificant (only 10 reference papers from 1992 to 2011). In 2012, 3 papers were published, which represents highest number of reference papers published in a

year. It seems that the increasing trend of total number of published papers is not followed by appropriate increase in reference papers.

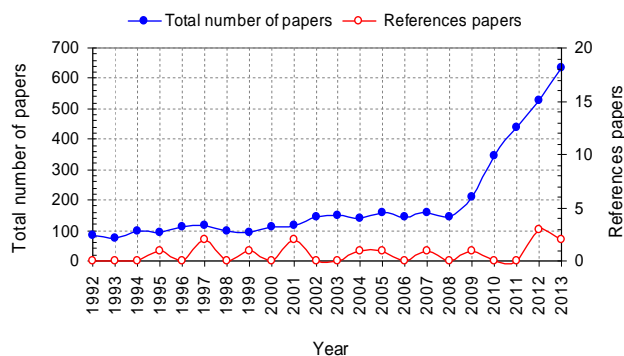


Fig. 3. Evolution of papers and references in Food Research International

International Journal of Food Properties is a journal with the latest date. Of the total number of published papers (1219), 32 papers (2.63%) refer to determination of sorption isotherms. Figure 4 shows that number of papers in which sorption isotherms are determined, is maximum 4 published papers in 2002 and 2010. It seems that this journal have confidence trend, but trend is disturbed in 2008 and 2011 when no reference papers have been published.

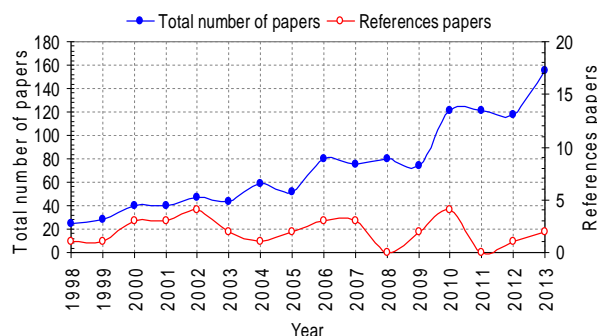


Fig. 4. Evolution of papers and references in International Journal of Food Properties

In Journal of Food Process Engineering from 1977 to 2013 the total number of published papers is 1293.

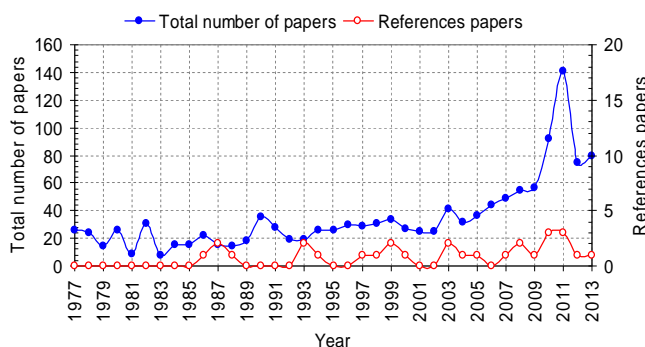


Fig. 5. Evolution of papers and references in Journal of Food Process Engineering

Only 28 papers i.e. 2.17% refer to determination of sorption isotherms. From Figure 5, it is obvious that number of reference papers is very small (maximum of 3 papers were published in 2010 and 2011).

Food and Bioproducts Processing is an official journal of the European Federation of Chemical Engineering in which from 1996 to 2013 the total number of published papers is 1102.

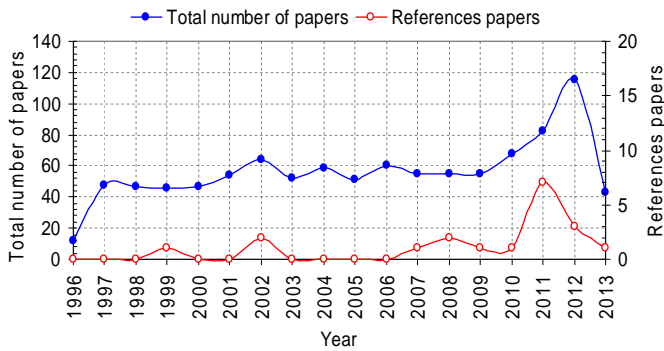


Fig. 6. Evolution of papers and references in Food and Bioproducts Processing

Of the total number of published papers in Food and Bioproducts Processing, 20 papers i.e. 1.81% refer to determination of sorption isotherms. Figure 6 confirms that number of papers in which sorption isotherms are determined, is insignificant (excluding 2011 where 7 papers were published).

International Journal of Food Science & Technology has edition from 1966. Of the total number of published papers 5525, only 99 papers i.e. 1.79% refer to determination of sorption isotherms. From Figure 7 it can be observed that number of reference papers is very small (excluding 2010 where 8 papers were published).

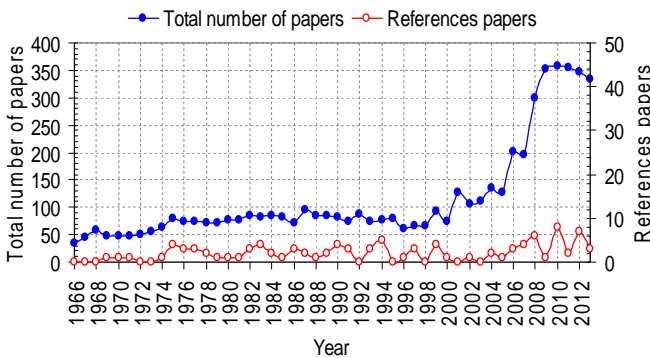


Fig. 7. Evolution of papers and references in International Journal of Food Science & Technology

Journal of Food Engineering is an official journal of the International Society of Food Engineering in which from 1982 to 2013 the total number of published papers is 6566.

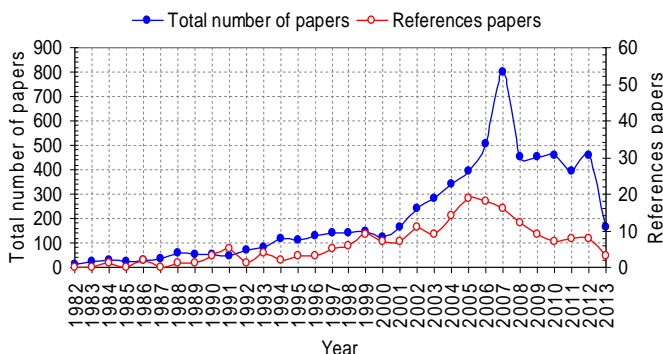


Fig. 8. Evolution of papers and references in Journal of Food Engineering

Out of the total number of published papers in this journal, 195 papers i.e. 2.97% refer to determination of sorption isotherms. From Figure 8 it can be concluded that the trend of number of papers in which the sorption isotherms are determined

is very different. From 1982 to 1997 it is very small, but from 1998 to 2012 it has a stable trend and surprising decline in 2013.

LWT Food Science and Technology is an official journal of the Swiss Society of Food Science and Technology in which from 1993 to 2013, 3821 papers were published.

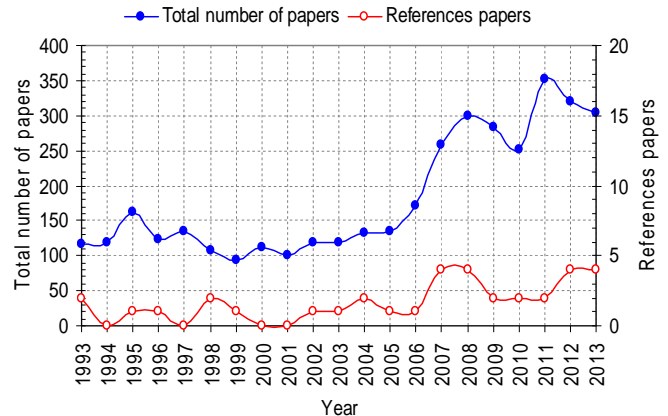


Fig. 9. Evolution of papers and references in LWT Food Science and Technology

Only 35 papers i.e. 0.92% refer to determination of sorption isotherms. From Figure 9 it can be observed that trend on number of reference papers is very low (maximum number of published papers is 4 in years 2007; 2008; 2012 and 2013).

It can be said that determination of sorption isotherms is field that has already reached its maturity. From the period of 1966-1988 the number of reference papers is very small (excluding 1993, 1994 and 1997 when 13, 13 and 22 reference papers were published accordingly).

From Figure 10 it can be noticed that during the period 1999 to 2012 the scientific output has been growing and maintaining stable trend, which is not the case in 2013. Although only three journals (Drying Technology-An International Journal, International Journal of Food Science & Technology and Journal of Food Engineering) host more than 78% of total publications, more 'younger' journals accept papers in which sorption isotherms are determined.

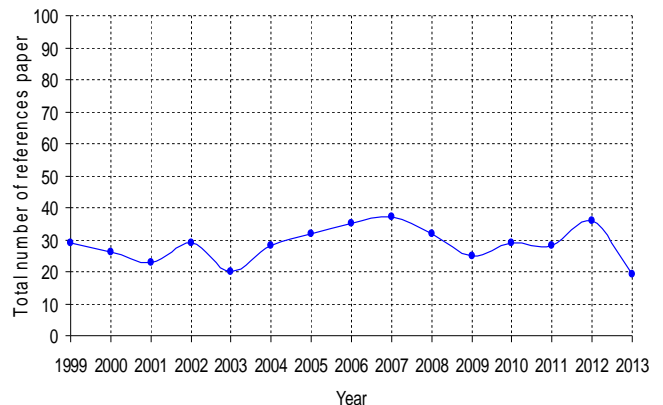


Fig. 10. Evolution of total number of reference papers

### SOME STATISTICAL INFORMATION

In order to obtain clear picture what is realistic to expect from the scientific investigation in the field of determination of sorption isotherms for different materials in the near future and where future research in this field should be focused, some statistical information is required. For this reason, the papers in which sorption isotherms were determined have been classified into nine categories: 1. Papers in which are determination of sorp-

tion isotherms of Fruits; II. Vegetables; III. Tea, Herbs, Coffee and Tobacco; IV. Pistachio nuts, Almond, Soybean and Cereals; V. Flour, Pasta and Powder milk; VI. Meat and Fish; VII. Foodstuffs; VIII. Wood, Paper and Clay and IX. Pharmaceutical materials. It must be pointed out that some papers are simultaneously classified in more than one category because they cover several classes. Analysis is performed separately for each journal.

The results of papers classification published in *Drying Technology - An International Journal*, is shown on Figure 11. It is obvious that the category of papers 'Foodstuffs' are the most frequent - 27%, while the categorie 'Flour, pasta and powder milk' contains the least papers, only 4%.

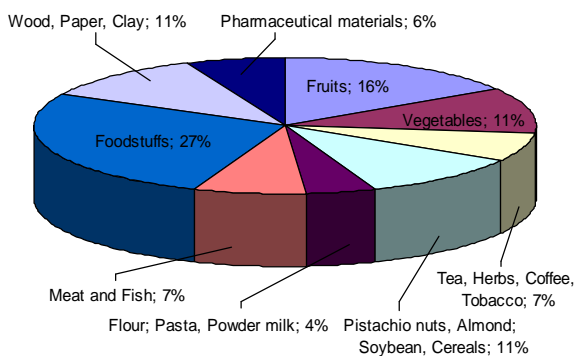


Fig. 11. Categories of the papers in which sorption isotherms are determined - *Drying Technology-An International Journal*

Figure 12 provides some statistical information for the categories of papers published in *Food Research International Journal*. It can be seen that the category of papers 'Foodstuffs' are the most frequent - 31%, while the categories 'Fruits' and 'Tea, Herbs, Coffee and Tobacco' contain 0 papers.

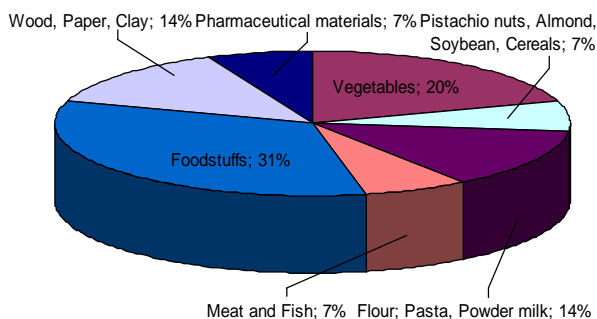


Fig.12. Categories of the papers in which sorption isotherms are determined - *Food Research International*

Figure 13 shows that the category of papers published in *Journal of Food Properties* is the most frequent with frequency of 28%, while the categories 'Tea, Herbs, Coffee and Tobacco' and 'Wood, Paper and Clay' contain 0 papers.

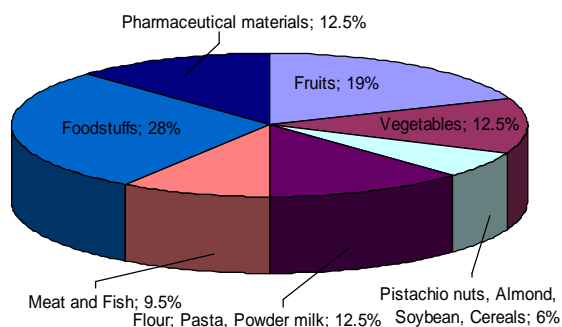


Fig.13. Categories of the papers in which sorption isotherms are determined-*International Journal of Food Properties*

From the Figure 14 it can be seen that the category of papers 'Pistachio nuts, Almonds, Soybean and Cereals' published in *Journal of Food Process Engineering* is the most frequent - 32%, while the categories 'Meat and Fish', 'Wood, Paper and Clay' and 'Pharmaceutical materials' contain 0 papers.

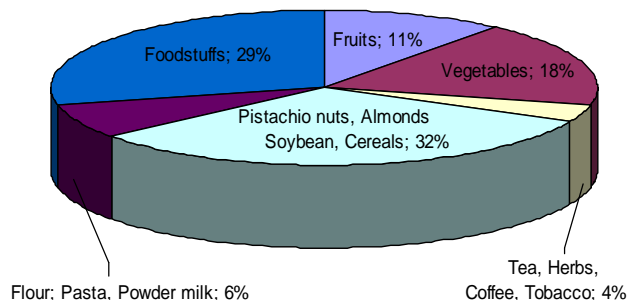


Fig. 14. Categories of the papers in which sorption isotherms are determined - *Journal of Food Process Engineering*

The categories of papers published in *Food and Bioproducts Processing journal* are shown in Figure 15. The papers in which sorption isotherms of 'Fruits' were determined, is the most frequent 30%, while the categories 'Flour, Pasta and Powder milk' and 'Wood, Paper and Clay' contain 0 papers.

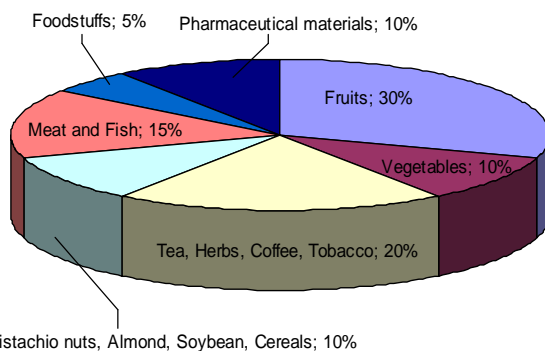


Fig. 15. Categories of the papers in which sorption isotherms are determined - *Food and Bioproducts Processing*

From the Figure 16 it is obvious that the category of papers 'Foodstuffs' published in *International Journal of Food Science and Technology* is the most frequent with 24%, while the category 'Wood, Paper and Clay' contains 0 papers.

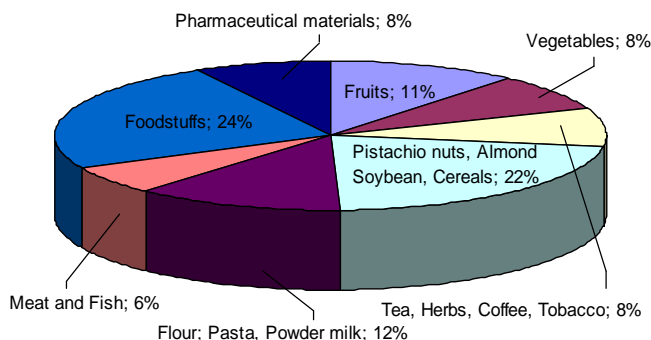


Fig. 16. Categories of the papers in which sorption isotherms are determined - *International Journal of Food Science and Technology*

In *Journal of Food Engineering* the category of papers 'Foodstuffs' with 20.5%, and category of papers 'Fruits' with 17% are the most frequent (figure 17).



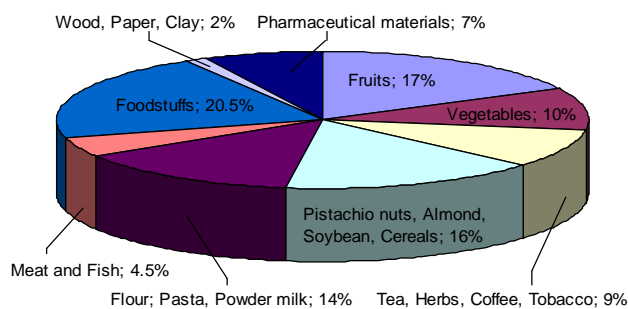


Fig. 17. Categories of the papers in which are determination sorption isotherms-*Journal of Food Engineering*

From the Figure 18 it can be seen that in the papers in which sorption isotherms were determined, 26% are from the category 'Foodstuffs', 17%, are in categories 'Fruits' and 17% 'Pistachio nuts, Almond, Soybean and Cereals'. These three categories are the most frequent. On the other hand, category of papers 'Wood, Paper and Clay' contains 0 papers.

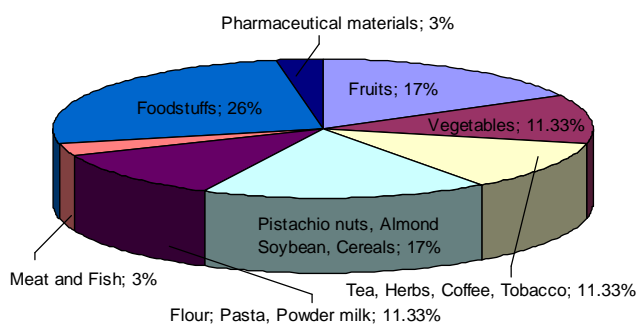


Fig. 18. Categories of the papers in which sorption isotherms are determined - *LWT Food Science and Technology*

Statistically speaking, Figure 19 provides quantities review into development of reference papers in general. The total number of papers in which sorption isotherms of different materials are determined is 584.

It can be seen that the category of papers 'Foodstuffs' is the most frequent with 139 papers i.e. 23.88%, while the category of papers 'Fruits' with 91 papers i.e. 15.64% and 'Pistachio nuts, Almond, Soybean and Cereals' with 90 papers i.e. 15.46% represent a significant fraction of the total reference papers.

The category of papers 'Vegetables' with 62 papers i.e. 10.65% and the category 'Flour, Pasta and Powder milk' with 58 papers i.e. 9.97% are not negligible. 46 papers i.e. 7.91%, in category 'Tea, Herbs, Coffee and Tobacco', 40 papers i.e. 6.87% in category 'Pharmaceutical materials' and 34 papers i.e. 5.84% in category 'Meat and Fish', keep up with the previous categories. The category of papers 'Wood, Paper and Clay' with 22 papers i.e. 3.78% is the least frequent.

From performed statistical analysis, it can be concluded that in near future scientific investigation in the field of determination of sorption isotherms on 'Foodstuffs', 'Fruits', 'Pistachio nuts, Almond, Soybean and Cereals', 'Vegetables' and 'Flour, Pasta and Powder milk' still remain the most attractive and dominant. But, the determination of sorption isotherms of 'Tea, Herbs, Coffee and Tobacco', 'Pharmaceutical materials' and 'Meat and Fish' does not represent less attractive field of research. For this reason, future research should be focused on determination of sorption isotherms for these materials.

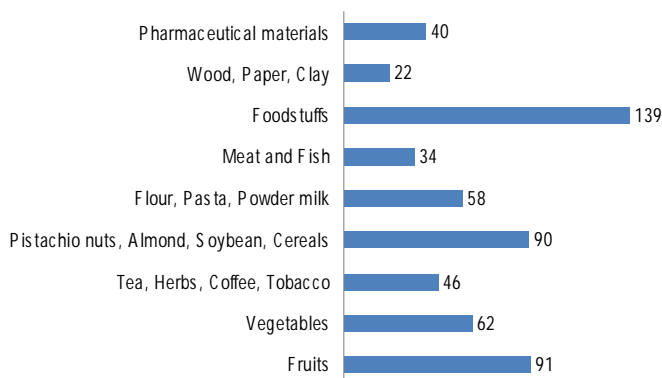


Fig. 19. Number of reference works classified in categories

## CONCLUSION

Although the conclusions extracted from the surveys have already been stated in the paper, here we can briefly enumerate the most outstanding findings of this paper:

Sorption isotherms have found its place in the design and optimization of drying equipment, design of packages and predictions of quality of materials

Some materials, traditionally, are more attractive from the others, so there is a different level of interest in the study

Papers in which sorption isotherms of different materials are determined, are published in a wide variety of journals and they cover a lot of materials

During the period from 1999 to 2012 the scientific output has been growing and maintaining stable trend, which is not the case in year 2013

Three journals (*Drying Technology-An International Journal*, *International Journal of Food Science & Technology* and *Journal of Food Engineering*) host more than 78% from total number of publications

Although the categories of papers 'Foodstuffs', 'Fruits', 'Pistachio nuts, Almond, Soybean and Cereals', 'Vegetables' and 'Flour, Pasta and Powder milk' comprise 75.6% of the applications, still there is a space for experimental determination of sorption isotherms of these materials, so that means that the peak of investigation is not reached yet

The remaining categories of papers for 'Tea, Herbs, Coffee and Tobacco', 'Pharmaceutical materials', 'Meat and Fish' and 'Wood, Paper and Clay' are 24.4% of the applications which means that more investigations are needed in this area.

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