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Assessment of conformity of volumetric capacity of casseroles and cauldrons to manufacturer's specifications and the Brazilian legislation

Avaliação da conformidade de capacidade volumétrica de caçarolas e caldeirões frente às especificações do fabricante e a legislação brasileira

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Abstract

Aluminum casseroles and cauldrons are indispensable tools in domestic kitchens and food and nutrition units (FNU). Knowledge about their volumetric capacity has relevance in practice of FNUs, since it leads to more effective control of the management and portioning of food, thus reducing the chances of waste or optimizing food storage space. Thus, this study was planned to assess if the volumetric capacity of casseroles and cauldrons, described by the manufacturers, reflects the actual values analyzed and if they are in accordance with the current legislation. Were studied twelve kinds of casseroles and nine kinds of cauldrons. The evaluations were made in three repetitions. Analysis of variance and Student's t-test were used for comparisons of the values described by the manufacturers versus the actual measurement found. The values were compared with those described by the Brazilian Legislation in force. The volumetric capacity values reported by the manufacturers, when compared with the measured ones, showed no statistically significant difference. However, there was significant volumetric variation permitted by the legislation and the lack of clarity on the accuracy of volumetric capacity of industrial-line casseroles and cauldrons used in FNUs. There was non-compliance with the legislation regarding the information to be included on a permanent basis in the body of the pans and cauldrons on 72 % of the analyzed utensils. It is concluded that care is needed in using these tools during the preparation of food. Reformulation is suggested of the Brazilian

standard on the volumetric capacity of these items, considering volume variation that does not exceed 20%.

Key words: Food Services. Cooking and Eating Utensils. Science and Technology Regislation. Weights and Measures. Technical Standards.

Resumo

As caçarolas e caldeirões de alumínios são utensílios indispensáveis em cozinhas domésticas e Unidades de Alimentação e Nutrição (UAN). Conhecer sua capacidade volumétrica possui relevância na prática das UANs, uma vez que conduz ao controle mais efetivo quanto à administração e porcionamento dos alimentos, reduzindo as chances de desperdícios ou otimizando o espaço de seu armazenamento. Assim, planejou-se o presente estudo a fim de avaliar se a capacidade volumétrica de caçarolas e caldeirões, descrita pelos fabricantes, encontra-se de acordo com os valores reais analisados e em concordância com a legislação. Foram estudados 12 tipos de caçarolas e nove tipos de caldeirões. As avaliações foram feitas em triplicatas. Análise de variância e o teste t de *Student* foram utilizados para as comparações dos valores descritos pelos Fabricantes *versus* Medida Real encontrada. Os valores foram comparados com os descritos pela legislação brasileira em vigor. Os valores da capacidade volumétrica anunciados pelos fabricantes, quando comparados com os avaliados, não apresentaram diferenças estatisticamente significantes. Todavia, salienta-se a expressiva variação volumétrica permitida pela legislação e a falta de clareza na exatidão da capacidade volumétrica de caçarolas e caldeirões da linha industrial, utilizadas nas UANs. Observou-se não conformidade com a legislação quanto às informações que devem constar de forma permanente no corpo das caçarolas e caldeirões em 72% dos analisados. Conclui-se que são necessários cuidados na utilização desses utensílios, durante a elaboração de preparações culinárias. Sugere-se reformulação da norma brasileira sobre a capacidade volumétrica desses produtos, considerando variações volumétricas não superiores a 20%.

Palavras-chave: Serviços de Alimentação. Utensílios de Alimentação e Culinária. Legislação em Ciência e Tecnologia. Pesos e Medidas. Normas Técnicas.

Introduction

Portuguese influence in Brazilian cuisine and in the habit of using metallic pans has been observed since Colonial Brazil (the period from 1500, with the arrival of the Portuguese, until 1815).[1]

Participation of a wide variety of materials used by man in manufacturing pots is a striking feature in the Brazilian territory, where pots commercialized are made of glass, bronze, ceramics, copper, enamels, iron, stainless steel, soapstone, earthen, aluminum with polytetrafluoroethylene (PTFE) (the best known brand name of PTFE-based formulas is Teflon by American chemical company Chemours Company), aluminum with stainless steel, cast aluminum or rolled aluminum.[2,3]

Since the twentieth century pots would be predominantly produced in aluminum and stainless steel and this because of the ease of handling and lower cost.[2,4]

It is known that, at present, other factors linked to those cited favor the sale success of aluminum cookware, such as greater resistance to corrosion and excellence in thermal conductivity, providing homogeneous conduction of heat which favors the uniform cooking of food.

For the technical requirements involved in metal cookware manufacture, the utensil body can be manufactured from the following materials: rolled aluminum, cast aluminum or rolled stainless steel, rolled steel for medium or deep stamping, cast iron and copper.[5]

In the production of cast aluminum pots, also known as handmade aluminum cookware, recycled materials from wrecking yards are used, ranging from old car plates (scrap) to building materials. This aluminum is melted at high temperature for manufacture of pans.[6]

On the other hand, in the manufacture of rolled aluminum pans, a machine known as metal lathe is used, where a rolled aluminum disc is drawn for forming the aluminum pan.

Currently, rolled aluminum pans and pots are widely used and have been classified by manufacturers as domestic and hotel lines, the latter also known as industrial line.

Aluminum pans are large, deep dishes with high edges but wider than high, with handle and lid of varying sizes.[7] As for aluminum pots, they are large, taller than wide pots, commonly having an arc-shaped hanger.[8]

Aluminum pans and pots are considered basic cookware in domestic kitchens and Food and Nutrition Units (FNU).[9,10]

Aiming to guarantee consumers' safety, Brazilian legislation has formulated guidelines for evaluation of these cookware conformity in the domestic line.[5, 11]

The volumetric capacity consists in the total volume contained by such pans body up to their limit before overflowing and can only be reached if the cookware is in adequate conditions.[12]

Rolled aluminum pans and pots found in the market differ from each other because of their designation. What is understood as designation is the number entered on the pan body, which represents the cookware volumetric capacity.[12] In the domestic line the following designations are found for sales: 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34. Designations above 34 make up the hotel line, also known as industrial line.

When analyzing the aluminum pans and pots industrial line available for sale, the following designations are found (no.): 36, 38, 40, 45, 50, 55, 60, 70. And the volumetric capacity values vary from 17 liters for designation 36 to 125 liters for 70 liters.

In 2012, technical requirements were laid down by law stipulating that during manufacture of aluminum pans and pots, manufacturers clearly and permanently mark the company name, designation and nominal diameter at the bottom of such cookware in order to ensure tracing.[5]

ABNT [*Associação Brasileira de Normas Técnicas* (Brazilian National Standards Organization)], through a Study Committee in 2008, developed NBR [*Norma Brasileira Regulamentadora* (Brazilian Regulatory Standard)]: 14630, which regulates domestic metal cookware for use in oven and stove.[12]

Different usage modalities influence the choice and dimensioning of such cookware in FNUs, such as: menu standard, number of meals, purchasing policy, labor force, investment profitability, distribution system.[13]

Knowledge about aluminum pans and pots volumetric capacity has relevance in domestic or FNU kitchens practices since this clarification leads to some more effective control in administration and portioning of food prepared in such cookware in order to avoid food waste and better optimization of storage space.

However, there are still studies in the literature evaluating whether the volumetric capacity values of pans and pots, as described by the manufacturers, are in accordance with the current legislation.[5,11,12]

Thus, this study was designed to evaluate whether aluminum pans and pots volume capacity described by manufacturers is compatible with actual values analyzed and in accordance with the legislation.

Methods

This is a cross-sectional, analytical and prospective study.[14] It was carried out in the city of São Paulo during the period from October 2014 to August 2015.

Samples were purchased for convenience and obtained by the researchers in stores that sell equipment and cookware for domestic and industrial kitchens.

Designation of pans and pots investigated

It was possible to perform the study in 12 designations of aluminum pans and nine of aluminum pots. Evaluations were carried out in triplicates, totaling 36 pans and 27 pots of two brands (brands A and B).

Pans designations investigated were those of numbers 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36 and 38, being three pans of each designation. And the pots designations evaluated were those of numbers 16, 26, 28, 30, 32, 34, 36, 38 and 40, being three pots of each designation.

Fifteen pans analyzed belonged to brand A and 21 to brand B. For the pots, nine to A and 18 to B.

Evaluation of the actual volumetric capacity

The project was carried out at the nutrition laboratory at *Universidade Paulista*, São Paulo, Brazil.

All pans and pots were made of rolled aluminum, without internal coating, new and free from defects in order to favor results accuracy.

Aluminum pans and pots volumetric capacity was defined in NBR paragraph 3.1: 14630 of ABNT [*Associação Brasileira de Normas Técnicas* (Brazilian National Standards Organization)] (2008), such as the total volume contained in the cookware body up to its limit before overflow.[12]

Subsequently, telephone calls were made to companies manufacturing aluminum pans and pots in order to know the methodology used to determine the volumetric capacity. Two companies involved claim to follow the standards recommended by ABNT (2008).[12]

In this study, as a comparison, such specifications, according to the legislation, were followed for determination of values corresponding to aluminum pans and pots actual measurement.

Cookware volumetric capacity measurement was carried out with water, with maximum capacity of 2,000 milliliters.

For reading the volumetric capacity, each cookware was placed on a flat surface with support from the test tube and the pots body was filled with water until the height of the overflow limit point.[12]

Reading of the values found during the measurement in the laboratory was described in the present study as a Real Measure. Measurements were carried out in triplicates for each pan and pot investigated.

Average values of pans and pots measurements were inserted into a *Microsoft Excel* spreadsheet and compared with the values specified by the manufacturer on the cookware labels.

Subsequently, results were analyzed according to the Brazilian legislation in force at the time of data evaluation: NBR 14630 of ABNT (2008), ordinance No. 398, of July 31, 2012, of the [Brazilian federal autarchy INMETRO (National Institute of Metrology, Standardization and Industrial Quality) and ordinance No. 408 of August 21, 2015 of INMETRO to verify agreement between the values found with those described by the manufacturers.[5,11,12]

The data analyses were performed using the software Stata version 11.0. (Stata Corp. College Station, United States of America). In all tests, a significance level of 5% ($p < 0.05$) was set for rejection of the null hypothesis.

Analysis of variance and *Student's t-test* were used for comparisons between two measures, that is, obtaining the volumetric capacity reported by the manufacturer versus Real Measure.

The study was approved by the Research Ethics Committee (REC) of this institution, CAAE: 36422814.2.0000.5512 and number of opinion 827338 of October 9, 2014.

Results

Of the 36 aluminum pans investigated, 42% corresponded to brand A and 58% to B, while of 27 pots, 33% to A and 67% to B. It is observed that the volumetric capacity values found in the Real Measure, when compared to the values announced by the manufacturers, do not present statistically significant differences. These values are described in Tables 1 and 2.

Table 1. Description of designation and volumetric capacity of aluminum pans and pots described by manufacturers and average values of actual measurement according to different brands evaluated. São Paulo, 2015.

PANS DESIGNATIONS	BRAND	VOLUMETRIC CAPACITY SPECIFICATIONS OF MANUFACTURER LT	AVERAGE VALUES REAL MEASURE (N = 3)
No. 16	A	1.6	1.63
No. 18	A	2.2	2.29
No. 20	A	3.1	3.2
No. 22	A	4.1	4
No. 24	A	5.6	5.79
No. 26	B	6.8	6.19
No. 28	B	8.3	7.9
No. 30	B	9.5	10.4
No. 32	B	12	11.7
No. 34	B	14.5	14.04
No. 36	B	17	16.7
No. 38	B	20	19.1
POTS DESIGNATIONS	BRAND		
No. 16	A	3.2	3.02
No. 26	A	12.7	12.3
No. 28	B	15.3	14.5
No. 30	B	19	18.2
No. 32	B	22.5	22.2
No. 34	B	27	26.9
No. 36	B	32.5	32.2
No. 38	B	38	38.2
No. 40	A	45	44.9

Table 2. Comparison of pans and pots volumetric capacity described by manufacturers on cookware labels with actual measurements. São Paulo, 2015.

Cookware	Manufacturer Mean (SD)	Real Measure Mean (SD)	p
Pan (n = 36)	8.73 (3.03)	8.58 (5.81)	0.992
Pot (n = 27)	23.91 (13.14)	23.60 (13.34)	0.979

Student's t-test at 5% error probability level.

Analyzing the values recommended by NBR 14630 of ABNT (2008),[12] it is observed that 94% of the pans belonging to the domestic line evaluated were in conformity. And 100% of the domestic line pots corresponded to the standards expected for volumetric compliance. These data were described in Table 3.

Table 3. Comparative evaluation among aluminum pans and pots volumetric capacity values provided by manufacturers and their compliance with variation limits allowed by NBR [*Norma Brasileira Regulamentadora* (Brazilian Regulatory Standard)] 14630 of ABNT [*Associação Brasileira de Normas Técnicas* (Brazilian National Standards Organization)] (2008). São Paulo, 2015.

Designation[1]	Volumetric capacity According to ABNT NBR 14630:2008 L	Volumetric capacity according to manufacturers	Compliance
	Pans		
No. 16	1.20 – 1.80	1.60	Compliant
No. 18	1.50 – 2.30	2.20	Compliant
No. 20	2.10 – 3.3	3.10	Compliant
No. 22	2.90 – 4.30	4.10	Compliant
No. 24	3.50 – 5.40	5.60	Non-compliant
No. 26	5.00 – 7.00	6.30	Compliant
No. 28	6.50 – 8.50	8.30	Compliant
No. 30	8.50 – 11.50	9.50	Compliant
No. 32	10.50 – 13.50	12.0	Compliant
No. 34	13.0 – 17.0	14.50	Compliant
No. 36	Unspecified	17.0	*
No. 38	Unspecified	20.0	*
	Pots		
No. 16	> 1.80	3.20	Compliant
No. 26	> 7.00	8.30	Compliant
No. 28	> 8.50	10.30	Compliant
No. 30	> 11.50	12.70	Compliant
No. 32	> 13.5	15.30	Compliant
No. 34	> 17.0	19.00	Compliant
No. 36	Unspecified	22.50	*
No. 38	Unspecified	27.00	*
No. 40	Unspecified	45.00	*

*Designation of the industrial line unspecified by ABNT NBR 14630:2008 and compliance evaluation is not possible.

In the present study, it was not possible to carry out the comparative evaluation regarding the conformity of the industrial line cookware (designations no. 36, 38 of pans and no. 36, 38, 40 of pots), since NBR 14630 of ABNT (2008)[12] does not clearly specify the values for acceptable variation for volumetric capacity of aluminum pans and pots belonging to that line.

When considering ordinance No. 398 of July 31, 2012, of INMETRO it is highlighted that 72% of aluminum pans and pots were found to be noncompliant due to the absence of the company name, designation and nominal diameter, which should be permanently described on the cookware body in order to ensure tracing the cookware and greater guarantee of consumer safety.[5]

However, ordinance No. 408 of August 21, 2015, of INMETRO,[11] which regulates quality and conformity assessment requirements for domestic cookware, provides that manufacturers of metal cookware have a deadline of up to October 13, 2017, to comply with requirements of ordinance No. 398, of July 31, 2012, of INMETRO.[5]

All variations permitted in the volumetric capacity for the various types of aluminum pans and pots determined by NBR 14630 of ABNT (2008) were described in Table 1, in which it is shown that for pots only lower limit values were designated for the volumetric capacity of each domestic line designation. And there is no precise information on the boundary values for industrial line aluminum pans and pots volumetric capacity.

Chart 1. Designation and volumetric capacity of pans and pots for use in the oven and stove according to standards recommended by ABNT NBR 14630 (2008). São Paulo, 2015.

Designation[1]	Volumetric capacity (vc) ml	
	Pan	Pot
8	400 ≤ vc ≤ 600	vc > 600
10	500 ≤ vc ≤ 700	vc > 700
12	700 ≤ vc ≤ 900	vc > 900
14	1000 ≤ vc ≤ 1200	vc > 1200
16	1200 ≤ vc ≤ 1800	vc > 1800
18	1500 ≤ vc ≤ 2300	vc > 2300
20	2100 ≤ vc ≤ 3300	vc > 3300
22	2900 ≤ vc ≤ 4300	vc > 4300
24	3500 ≤ vc ≤ 5400	vc > 5400
26	5000 ≤ vc ≤ 7000	vc > 7000
28	6500 ≤ vc ≤ 8500	vc > 8500
30	8500 ≤ vc ≤ 11500	vc > 11500
32	10500 ≤ vc ≤ 13500	vc > 13500
34	13000 ≤ vc ≤ 17000	vc > 17000

[1]Designation which does not fall within this Table shall be classified according to the whole number of the immediately prior designation.

Discussion

In the present study, no other research has been found in national and international literatures evaluating whether aluminum pans and pots volume capacity described by the manufacturers is compatible with the actual values analyzed and in accordance with legislation.

In this way, the importance of the subject addressed and the limitations of the present study in not being able to obtain results from other pieces of research for greater comprehension of the discussion on this subject is emphasized.

When assessing the volumetric capacity conformity between the values described by NBR 14630 of ABNT (2008) with the values reported by Manufacturers versus Real Measures, it was found that 94% of domestic pans and pots comply with the conformity standard. Pans and pots volumetric values analyzed have oscillated between 100 ml and 2.500 ml.

However, despite the high compliance among the values described by Manufacturers versus Real Measures, when compared to values in NBR 14630 of ABNT (2008), a significant volumetric variation is allowed, since the volumetric variants percentage values of the various pan designations vary from 20% to 57%, with an average percentage variation of 40%, showing how much this legislation allows a large volumetric variation in such cookware.[12]

Some trend for NBR 14630 of ABNT (2008) was observed in leading readers to errors in knowledge of aluminum pans volumetric capacity, since some of them fall into more than one designation.

This fact can be demonstrated in the acquisition of a pan with a volumetric capacity of 500 ml, which may fit into designations No. 8 or 10. The same misconception was observed for pans with volumetric capacities of 2,100 ml, 5,000 ml, 6,500 ml, 10,500 ml, 13,000 ml, all of which may fit into more than one designation, a fact that could be detrimental to consumers at the time of purchase due to some tendency towards greater cost in acquiring the larger designations.

It should also be noted that there is no designation for pans with volumetric capacities ≥ 901 ml and ≤ 999 ml.

In relation to pots, it was observed that NBR 14630 of ABNT (2008) determines only lower limits of volumetric capacity. Thus, pots in designation No. 8, for example, may range from 601 ml to infinity. The same idea applies to other pots designations in the domestic line described.[12]

The importance of this discussion is emphasized in that the industrial line involves aluminum pans and pots with higher volumetric capacity than the domestic line and the volumetric errors represent larger losses. Therefore, volumetric variation should be better controlled in order to avoid FNU financial loss due to food waste or less optimization of preparation time due to lack of clarity as to the cookware designation.

An example to be mentioned is when it is believed that aluminum pans and pots have a certain volumetric capacity and when producing food this one is lost because of ignoring the cookware designation, which ends up increasing menu costs due to the inconvenience of unexpected losses. Or, on the other hand, when the volumetric capacity is greater than that described in the cookware designation and unexpectedly ends up optimizing the food storage space during preparation, which could have offered greater time savings if it were produced only once if the actual volumetric capacity were known.[15]

Another inconvenient observed in NBR 14630 of ABNT (2008) is the difficulty in accessing such information. To obtain it one must pay for it. Therefore, part of the population is deprived of acquiring knowledge about norms established that must be followed by manufacturers.[12]

Also considered was NBR 14630 of ABNT (2008), which is difficult to understand and presents ambiguities of expressions, since one has written in Table 1 footer: "Designation not falling within this Table shall be classified according to the whole number of the immediately prior designation."

According to ordinance No. 398 of July 31, 2012, of INMETRO, the designation, company name and nominal diameter shall be permanently marked on the cookware body.[5] However, in the present study most of the manufacturers (72%) have provided some adhesive paper containing the supplier's name, volumetric capacity and identification for tracing. However, since the lay population lacks understanding of the importance of storing data on the manufacturer, the adhesive paper is often overlooked and in this way opportunity for possible future tracing is lost.

Therefore, over time it is impractical to use such cookware with volumetric accuracy during the preparation of culinary recipes, since such data shall possibly be lost, for many companies do not present this information permanently in the cookware body yet, according to what is preconized by ordinance No. 398, of INMETRO (2012).[5] However, it is worth noting that manufacturers have support for this practice through ordinance No. 408 of August 21, 2015, of INMETRO, which allows manufacturers to comply by mid-October 2017.

Cookware traceability is of utmost importance, since in the event of some health problem the batch identification of aluminum pans and pots for some type of toxic material can be recognized and recalled from the market, as well as to define the responsibility of each one of the players in production. Therefore this enables rapid intervention by relevant authorities.

Tracing also favors monitoring qualified companies that ensure suitability for the nominal diameter (coating thickness) so that consumers are not deceived as to the cookware life and the presence of dilations in this one according to use, which may favor the formation of undulations, which interferes with the total volumetric capacity, which are practices that can be carried out by non-reputable companies that do not meet the nominal diameter determined by NBR and ordinance No. 398 of July 31, 2012, of INMETRO.[5,12]

In practice, one notes the lack of volumetric capacities standardization for cookware and equipment at the FNU among industrial line supplying companies.[13] There is also some lack of equipment nomenclature at the FNUs. For example, a cart can mean a thermal cart, a platform-type transport cart or a shelf-type cart.[13]

There is lack of consensus in the literature on the differences between descriptions of equipment and utensils used at FNUs, since utensils may include temporary or permanent machinery and household appliances.[13,16]

It is worth noting that the aluminum pot (utensil) evaluated in the present study should not be confused with the steam pot (equipment) sometimes described in the literature as "pot," since in practice the volumetric evaluations between them are different.[12,17,18]

Another aspect to be questioned is the absence of an instruction manual during the acquisition of such cookware to provide assurance and greater security to clients about possible increases in rates of aluminum dissolution while cooking and preparing acid food and also during the use of new aluminum pans.[3,19]

Conclusions

This study has thus contributed to demonstrate that the volumetric capacity of aluminum pans and pots analyzed is in accordance with current legislation and volumetric values provided by manufacturers.

However, when considering the average percentage value among variations in volumetric capacity of different pans described in NBR 14630 of ABNT (2008), mean percentage change of 40% was observed. This is some worrisome data, since such percentage value is supported by the NBR. However, it was considered expressive by the authors of the present research.

The importance of the topic discussed here is emphasized, considering variations allowed by NBR 14630 of ABNT (2008) and regarding the pans and pots volumetric capacity, it is suggested:

Greater care in the use of such cookware in the development of culinary preparations due to the volumetric variations observed and allowed by such legislation.[12]

Reformulation of the NBR [*Norma Brasileira Regulamentadora* (Brazilian Regulatory Standard)][12] on the recommendations of maximum and minimum volumetric capacity values for designations of pans and pots in domestic and industrial lines, taking into account volumetric variations not exceeding 20%. Free access to the NBR by the Brazilian population.

Some limitation of the present study was the non-evaluation of the nominal diameter and level of impurity (lead, arsenic, cadmium, mercury and copper) of the metal parts of aluminum pots and pots. However, due to the subject relevance, the importance of new studies is highlighted in order to evaluate the percentage of conformity of the nominal diameter and the levels of impurity of such cookware among the values provided by manufacturers, values found and compliance with the values in the current legislation.[5,11,12]

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