Sampling in Brazil affords representativeness for monitoring of persistent organochlorines in products of animal origin. The 2004-2013 experience

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Introduction

Surveys are count procedures applied to two complimentary processes. For binary events (positive/negative) they are conducted to estimate the frequency of positive results in populational basis (prevalence). Besides that they provide the foundation for the detection of at least one positive case[5].

With epidemiologic surveys often is not operational/financially achievable to use census data. A survey sampling (*n* samples) is used to attain the rate of positives for a specified disease in the total number of individuals in the population (*N* individuals).

The term sample is used to indicate the set of *n* units withdrawn from the population (N) to calculate statistics that estimate population parameters.

Randomness is the basic assumption for sampling theory. The random selection of animals and count of the positive ones is an accurate picture of the population. In this case the frequency of event occurrence is expected being the same both in the sample and in the population. The randomization exerts a protection against the agglomerated selection of either positive or negative animals because those clumps of cases might distort the actual population proportion between positives and negatives, an event known as bias. Beyond randomness the reliability in sample representativeness depends upon sampling frame stratification, that is, the collection sites.

Sampling is essential to prospect disease occurrence in populations. By analogy the conformity or non-conformity (violation to maximum legal limits) can be evaluated in a binary format in the context of chemical residuals in food matrixes.

In Brazil the National Control Plan for Residues and Contaminants (PNCRC) is an initiative of the Ministry of Agriculture, Livestock and Food Supply (MAPA) that employs random sampling, stratified by size of slaughtering (meat, beef) or processing (milk, honey, eggs, fish). It applies to industries under federal inspection service (SIF) that represent the collecting sites out of the sampling lists referred by Thrusfield[5 (p. 153)]. The more animals are slaughtered/processed the better the chances of the enterprise to be selected in that strata (for tissue collection and analysis). The chance of selection for any animal is proportional to the processing size of the industry. Therefore, independent of the size of the farm of origin of the animals. Weekly drawings are made by computerized internet system - SISRES (Residues and Contaminants Control System) up to the achievement of all analysis expected for annual program.

Materials and methods

PNCRC annual results were provided by official State publications of the Brazilian government by monitoring year [2004: Ordinance SDA n° 77/2005; 2005: Ordinance SDA n° 222/2006; 2006: Normative Instruction SDA n° 08/2007; 2007: Normative Instruction SDA n° 09/2008; 2008: Normative Instruction SDA n° 15/2009; 2009: Normative Instruction SDA n° 06/2010; 2010: Normative Instruction SDA n° 06/2011; 2011: Normative Instruction SDA n° 07/2012; 2012: Normative Instruction SDA n° 07/2013; 2013: Ordinance SDA n° 60/2014].

In this survey were used the eletronic records of total annual analysis for 2004-2013 related to organochlorine residues and contaminants (pesticides, polycyclic aromatic hydrocarbons – HPAs and polychlorinated biphenyls – PCBs).

Win Episcopo 2.0[6] was used for calculation of the maximum expected prevalence based on binomial probability distribution considering the known number of annually negative samples for organochlorides and N≥10,000 as the total size for the sampled population (indicating an infinite population).

Results and discussion

In Brazil, sampling was updated since 2007 for organochlorines (residues and contaminants) in products of animal origin. In the years 2004, 2005, 2006, respectively, the n = 880, 1748, 1648 (mean=1425.33; σ=474.91) decreased to a mean of 269.43 annual samples (σ=143.04) between 2007-2013, as the *n* was 371, 235, 152, 277, 536, 132, 183 in each of the seven years in the latter period. That reduction was chronologically associated with the budget increase for the laboratory network of US$ 8 milion to more than US$ 21 milion in 2006-2007 and with application of equipment, reagents and quality assurance procedures according ISO 17025[4], as well the initiatives regarding the increase on the capability for detection thresholds in the context of the aims of a future advanced program for risk analysis.

Between 2004-2013 the annual results of national monitoring showed that there was zero violations for organochlorine compounds in Brazilian control plan (PNCRC). Taking into account the variation in the theoreticaly possible prevalences in 2004, 2005, 2006, calculated by Win Episcope 2.0 with the binomial probability distribution, the observed prevalences for violations were at most of 0.33%; 0.16%; 0.17% (mean=0.22%, σ=0.10%), respectively, with 95% confidence and of 0.50%; 0.25%; 0.26% (mean=0.34%, σ =0.14%) with 99% certainty. In 2007-2013 the mean 269.43 for the annual sample size of the seven years in the period indicated the maximum prevalence of 1.35% (σ =0.61%) violations, with 95% confidence, and in the same time 2.07% (σ =0.93%), with 99% confidence.

The results afforded by the sampling in the period 2004-2006 indicated maximum average prevalences of 0.22% (with 95% certainty) and of 0.34% (with 99% certainty)

For period 2007-2013 the maximum average prevalences of 1.35% (with 95% certainty) and of 2.07% (with 99% certainty) pointed out to a bigger risk to the occurence of violation regarding organochlorine compounds, despite being compatible with a suitable program for surveillance. It means that the sample size *n* in period 2007-2013 was sufficient to detect one single violation in the Brazil's animal population (considering the theoretical presence of at least one violation). As no violations occurred is possible to infer occurrence levels lower than 1.35-2.07%. Those levels are compatible with a controlled productive system even though with greater prevalences compared to period 2004-2006.

Since 2006, efforts to employment of modern essay methods using ISO 17025[1] framework at the official laboratory network have been progressively increasing. This is an analytical quality approach to improve the traceability and detection of pesticide and contaminant residues of organic/persistent nature (considering the application of different tools as validation, uncertainty, quality controls and others), therefore enhancing the reliability of Brazilian sample survey related to prohibition of pesticide use and to the screening of environmental pollutants in the organochlorine group.

Normative Instruction n°42[2] presents conceptual/operational information of the functional structure for PNCRC/MAPA. The sampling procedures are supported by the binomial probability distribution. The normative n°70 of *Codex Alimentarius* Comission (CAC)[3] brings the statistical appraisal for population size that *n* is based on binomial distribution and will be always equal or greater that of the hypergeometric distribution. At the same time assures the solely application of hypergeometric distribution to finite populations. Between binomial and hypergeometric probability distributions the former requires greater *n* and therefore is more prone to detect violations, particularly at low prevalences. That argument along with the binomial distribution indication to infinite populations (N > 10,000 individuals) comes to strengthen the technical virtue of the Brazilian official sampling program.

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