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Sensory Analysis in Quality Control: The Gin as an Example

Montserrat Riu Aumatell

*Universitat de Barcelona/ Departament Nutrició i Bromatologia
Spain*

1. Introduction

The quality of a food product could be defined by different ways from a widely manner to a more detailed one. One of the most usual meanings is define the quality as “in conformity with consumer’s requirements and acceptance, is determined by their sensory attributes, chemical composition, physical properties, and level of microbiological and toxicological contaminants, shelf-life, packaging and labelling”. In order to manage the quality of a food product most industries have defined quality control and quality assurance programs. In the recent years, a lot of companies have established a quality control/sensory program especially the food industry. Frequently the quality control of a food needs some multidisciplinary approaches. In the last years, the advances in instrumental techniques have been enormous, increasingly the sensitivity and selectivity of the analytes detection so the control of chemical composition or toxicological contaminants must be easier. In spite of these the perception of flavour product usually must be measured by sensory analysis. But only some of the food industry use a sensory program compared to other disciplines (Muñoz, 2002). However some companies confirmed a relationship between instrumental and sensory measurements. The sensory analysis is a scientific discipline in which man is a measure instrument. It is often defined as “a discipline used to evoke, measure, analyse and interpret reactions to the characteristics of foods and similar materials as they are perceived by the sense of sight, smell, taste, touch and hearing” (Mc Ilveen & Armstrong, 1996; Piggott, et al., 1998). The latter has the same requirements as the chemical determinations, thus it means, it must be accurate, precise and valid. The discipline of sensory analysis use scientific principles drawn back from food science, physiology, psychology and statistics (Piggott, et al., 1998). The sensory quality is much difficult because it depends not only of food characteristics but of the consumer (Costell, 2002). Thus sensory quality could be product oriented or consumer oriented. Therefore, the role of sensory analysis in the food industry could be more important than it is actually. Sensory analysis have different approaches, requirements, and practical applicability and usually requires a lot of time, difficulties in analyzing data and the expertise are not always available. Is difficult organize a trained panel test, to have the adequate reference standards, and difficulties in focus the objective for the analysis so to perform the optimum sensorial test. If it’s possible the sensory quality control must be applied to the ingredients or in-process. For this it’s important that companies stipulate the specifications of the raw material in order to avoid

the entrance of a defective ingredient in the product elaboration. This can suppose the detection of a defect in the finished product. Probably this kind of sensory evaluation will be more efficient. Sensory control is recommended only in critical steps while physical and chemical analyses are realized at different stages (Muñoz, 2002).

There are a great number of sensory methods. They can be divided in two groups' discriminant and descriptive methods (Piggott, et al., 1998). This chapter objective is to evaluate the role of the sensory quality control in the food industry. For this the most usual sensory methods were described and analyzed.

On the other hand, the industry of alcoholic beverages especially the spirit drinks is one of the most important of the world. Actually the improved communications and the expansion of travel have made the globalization a reality. Information about the sensory profile of alcoholic beverages could be interesting for the quality control of the worldwide beverage industry in order to obtain flavour integrity. Some alcoholic beverages as whiskey or brandy are widely studied. Other distilled beverages as gin in spite of they are widely consumed around the world there are few documented studies about this sensory profile (Piggott & Holm, 1983; Phelan et al., 2004; Riu-Aumatell et al., 2008). The descriptive analysis of gin is characterized by juniper and coriander preferably but other nuances could be detected when trained judges are used.

The sensory evaluation of gin as an alcoholic beverage example in the industry was studied. The references available about this topic were discussed.

2. Sensorial methods in food quality

Once the quality sensory standards were defined the optimum sensorial method was chosen. According to Costell, 2002, the choice of sensorial method depends of:

1. The objective of the quality control programme
2. The type of standard established
3. Whether or not the perceptible variability of a product can be defined by specific sensory attributes
4. The magnitude variability that must be detected
5. The level of quality to be assessed

The characteristics of a product are important to chosen the sensorial method. In order to perform a sensory quality control some preliminary steps must be taken into account, the first one the sensory quality specifications. Each company must define the quality standard of their products. The stability of a food product is an essential characteristic for a food quality. With foods it's very difficult to obtain products with uniform sensory characteristics during time. A definition of a descriptor should be given therefore a suitable stable reference should be assigned to a descriptor. The reference must be stable and reproducible with time. A standard for quality control is defined as "a representation for certain characteristics and a product that can be easily being obtained by, maintained or reproduced" (Costell, 2002). Some information about its variability and its influence on sensory attributes must be well defined. The variability of the standard must be quantified and also variation limits should be established.

Also, other factors that influence are the training of the panel, the conditions of the analysis, and the correct data analysis that are essential for the information obtained of the sensory analysis. Then to establish a quality program of sensory method also, it should be bear in

mind the training of the panellists when it was necessary, the type of established specifications and the use of controlled test conditions (Muñoz, 2002).

According to the authors considered, the sensorial methodology could be divided in different ways but the most usual and easy methods used in the quality control could be divided in discriminant and descriptive analysis. According to Muñoz et al., (1992), the sensory methods for quality control could be divided in eight types: overall difference test, difference from control, attribute or descriptive test, in/out of specifications, preference and other consumers test, typical measurements, qualitative description of typical production and quality grading. All of these methods present advantages and inconvenients. While according to Costell (2002), the most suitable test for the sensory quality control in the industry is that which make possible to measure a magnitude of variability between a product and a defined standard while a difference or acceptance test are not adequate. The difference test are too sensitive to small differences between products and do not determine the extent of a difference while the acceptance test with a small group of tasters not represent the consumer population. The most usual sensory methods for the sensory quality control are discussed below.

Sensory methods are usually classified in three categories: difference test (1), affective test (2) and descriptive test (3). Difference tests (1) are named of different manner but usually it could be divided in two ways: overall difference test and attribute difference test. The latter measures a single attribute of a sample which not imply that no overall difference exist between samples and includes the directional difference test named also paired comparison test or pair wise ranking test. While triangle, duo-trio, two-out-of-five and difference from control amongst others are test usually used by detect overall difference between samples. The most easily sensory methods for quality control are difference from control test. The aim of this test is to determine if a difference could be recognize between a sample and a control and to estimate the magnitude of the difference (Meilgaard, et al., 1999). Usually one sample is defined as control, standard or reference and the sample problem was evaluated with respect the control. The easier method should be the overall difference from standard. The judges rate the differences between a sample or samples and a control. Usually 20 or 50 presentations of the sample were needed. The judges must be semi trained. A more useful method should be to evaluate the difference between the sample and the standard but evaluating the differences of the most important attributes of the product (for example which sample of olive oil is more rancid). The latter should be more useful in order to apply corrections to the sample when it was necessary. When some change was applied to a food product it could be more useful use a scale with a control in the middle. This allows identifying the direction of a detected difference. It's no necessary that the subjects are trained only when the attribute is very important, for example a specific off-flavour, in this case the test requires high training judges.

The affective tests (2) evaluate the personal response (preference or acceptance) to a new product, or a single characteristic of a product. The affective tests involve the acceptance methods, the preference methods and the attribute diagnostics. The most usual test to evaluate a preference of a product includes paired preference, rank preference or multiple paired preferences. These test are based in arrange the food tested in the order of preference. The acceptance test is used by to rank the products in a scale of acceptability while attribute diagnostics consists in rank the principal attributes that determine the acceptance or the preference of the products. Some authors (as Costell, 2002) have the opinion that the affective test or the difference tests are not suitable for routine analysis. Probably, the

consumers are not prepared to identify flavours and sometimes they are not prepared to explain why they like or dislike a food sample. Affective test could provide a direct link between the consumer and the development and it could useful by marketing research (Sidel & Stone, 1993).

Probably, in quality control the most appropriate sensory methods are those that measure the magnitude of a variability of a sample between a standard. The objective of the methods involving the comparison to a standard evaluates the difference between a product and a standard. The standard must carry out the specifications of the method. The latter includes the methods cited in Table 1.

Comparison to a standard	Difference from a standard or a control product	
	Difference from a mental standard	In/out method Overall quality rating method
	Difference from a written standard	Quality grading method
Methods without standard	Descriptive methods	
	Other	

Table 1. The most usual methods used in sensory analysis according to Costell (2002)

The evaluation of difference between a sample and a control is useful when a food product have not very complex sensory characteristics. Generally one sample was considered the control or standard and the objective is the evaluation how different is the target sample from the control. Also, the magnitude of the difference was usually asked to the panellist. When a most important attributes were considered the analysis must be more useful because then the corrections necessary should be produced. Another possibility is use a scale which the control in the central point. This could be useful to understand the differences between the product and the control, for example when some change was produced in the formulation and it could be interesting to know the direction of the changes produced. The panel must be trained only when the difference between control and sample was taken into account. The use of a mental standard is not recommended but in some cases it could be useful for example in order to evaluate slight differences which modify the prize in foods as wine or olive oil or for example when the raw material or some ingredient was measured. Two methods evaluate the difference from a mental standard In/out method and overall quality rating method. In and out method is useful only when the differences were very clear or an off-flavour was considered. Another method is the Overall quality rating method. This method could be considered a mixture between an acceptance method and difference method. These cause that the results obtained are not easy to treat. When the method considered that a group of expert judges with a common mental standard could evaluate the overall quality of a food product. The results obtained do not translate into changes in food because it does not conclude in which direction and how the quality of the food differs from the mental standard. Therefore another method could be more useful as the quality grading method. This method analyses the basic attributes colour, flavour, texture and appearance. The attributes were evaluated by ordinary scales according to high quality, acceptable quality and rejected food. The judges must be very well trained in order to obtain significant results.

Finally it must be commented the methods which no need comparison to standard, basically Descriptive analysis. The descriptive methods (3) are the most sophisticated methods of sensory analysis and involve the detection and description of qualitative and quantitative attributes of a food product by a trained panel of judges. The qualitative attributes of a product involves aroma, appearance, flavour, texture, sound and aftertaste and the trained judges quantify these parameters to describe a target product (Murray, et al., 2001). Descriptive analysis is used in multiple ways as quality control, for comparison of product prototypes, for sensory mapping and product matching (Murray, et al., 2001). Descriptive analysis includes Flavour Profile Method, Texture Profile Method, Quantitative Descriptive Analysis TM, Spectrum TM method, Quantitative Flavour Profiling and Generic Descriptive Analysis. The last one, combines different characteristics of the other methods and is usually used in descriptive analysis of food. Descriptive analysis could also be used to relate the results obtained with preference ratings and with instrumental data. The most important considerations in descriptive analysis are a strict list of terms and a highly trained panel of judges. The list of attributes must be consensued by the panel below the direction of the panel leader. Usually the training of the panel takes place with reference standard, with intensity ranking test and sometimes with food samples enriched with the descriptors identified in the samples. The results obtained were analysed with spider web diagrams, one-way ANOVA and multivariate methods as Principal Components Analysis (PCA). Numerous food products were analysed by descriptive analysis as alcoholic beverages gin, wine, cheese, meat or coffee.

3. Gin

Gin is a distilled beverage developed in the northern Europe in 17th century. Gin is one of the distilled beverages widely consumed around the world and it belongs to the juniper flavoured spirit drinks category according the European legislation (Regulation (EC), no. 110/2008). According to the European regulation juniper-flavoured spirit drinks could be divided in juniper-flavoured spirit drink, Gin, Distilled Gin and London gin. The last one is the one of the most popular spirit drinks with global sales adding up to approximately 50 million cases by volume (according to The Gin and Vodka Association). Gin is a colourless beverage with an alcoholic strength of at least 40% in the United States and 37.5% in the European Union (Greer, et al., 2008). Regardless of the elaboration process always the predominant flavour is *Juniperus*.

The production of Gin depends basically of the beverage type. The juniper flavoured spirit drink and gin are elaborated by flavouring ethyl alcohol of agricultural origin with *Juniperus* berries (*Juniperus communis* L. in Gin and *J. Communis* L. and/or *J. Oxicedrus* L. in juniper-flavoured spirit drinks). Most usual is the distilled Gin obtained by redistilling organoleptically suitable ethyl alcohol of agricultural origin of an appropriate quality with an initial alcoholic strength of at least 96% in stills traditionally used for gin in the presence of juniper berries and other natural species provided that the juniper taste is predominant. The stills traditionally used to obtain distilled gin are usually made of copper. The stills are heated using a steam jacket to remove the essential oil from the botanicals which provide the taste to the beverage. The early part (fore shots) usually abounding in fusel oil and the end of the run (feints) are of lower quality and to produce high quality distilled gin only the middle run is used. Moreover, the minimum alcoholic strength by volume shall be 37.5%. The flavouring ingredients of gin are all natural and are referred as botanicals. These

botanicals are carefully selected qualitatively and quantitatively and vary according to the producer. Some authors talk about more than 100 botanicals added to a gin providing them its particular character. It could include mainly coriander seeds (*Coriander sativum* L.) but also other botanicals as orange peel (*Citrus sinensis*), purging cassia (*Cassia fistula*), orris root (*Iris florentina* L.), cardamom seeds (*Elettaria cardamomum* L.), angelica root (*Angelica archangelica* L.), cinnamon bark (*Cinnamomum zeylandicum*), calamus (*Acorus calamus* L.), fennel (*Foeniculum vulgare*), aniseed (*Pimpinella anisum*), lemon peel (*Citrus limon* L.), cumin (*Cuminum cyminum* L.), almond (*Prunus amygdalus* L.) and liquorice root (*Glycyrrhiza glabra*). Finally, the production process of London Dry Gin is similar of that of distilled gin with high quality distillate (maximum methanol content of 5 grams per hectolitre of 100% vol. alcohol), and which not contain other added ingredients than water and with no colorants and artificial flavouring ingredients added. Gin and distillate gin no needs any period of maturation.

Moreover, when the production of gin takes place in a geographical area and accomplish some requirements according to its elaboration, composition and quality they could receive the denomination of geographical indication as Genièvre/Jenever/Genever (Belgium, the Netherlands, France and Germany), Jonge jenever, Oude jenever (Belgium, the Netherlands), Genièvre Flandres Artois (France), Ostfriesischer Korngenever and Steinhäger (Germany), Plymouth Gin (United Kingdom), Gin de Mahón (Spain), Vilniaus Džinas/Vilnius Gin (Lithuania) and Spišská borovička (Slovakia).

3.1 Chemical composition

The same as all the spirituous beverages the gin flavour is provided by several volatile and semivolatile compounds. The volatile composition of gin depends mainly of the volatile compounds of juniper berries and other botanicals added to the spirituous beverage. According to Barjaktarović et al., (2005) the composition of juniper essential oil was formed by monoterpenes (58-85%), sesquiterpenes (2-10.2%) and other minority compounds as aldehydes, alcohols and oxygenated compounds.

According to our own experience the volatile composition of 6 Gins were performed mainly of terpenoid compounds. The samples analysed were 4 London Dry Gins and the other two were gins with geographical indication (Gin de Mahón and Plymouth Gin). More than 60 volatile and semivolatile compounds were identified and quantified by Headspace/Solid Phase Microextraction coupled to Gas Chromatography/ Mass Spectrometry (HS/SPME-GC/MS). They belong mainly to the terpenoids family (monoterpenes, sesquiterpenes and they corresponding oxygenated compounds). Table 2 showed the mean of the concentration (mg/L) of the main compounds identified in gin. Samples were separated by London Dry Gin and geographical indication.

The volatile profile of London Dry Gins analysed differs from that of gins with geographical indication. Also, from juniper berries some of the principal volatile compounds come from other botanicals used in its elaboration and it's very different according to the gin considered. Gin with geographical indication 5 showed a higher values of limonene and γ -terpinene and the sesquiterpenes δ and γ -cadinene. Limonene and γ -terpinene could provide from citric fruit other than juniper berries. While the terpenoid compounds characteristics of juniper berries are found in samples with geographical indication 6. Also this last sample contains the highest values of oxygenated monoterpenes as verbenyl ethyl ether (for the first time identified in gin samples) and α -terpineol.

	London Dry Gins (n=4)	Geographical indication 5	Geographical indication 6
α -pinene	2.55	6.12	5.65
β -myrcene	4.01	6.17	11.09
Limonene	3.99	17.21	5.74
γ -terpinene	1.25	2.87	1.51
Linalool	22.37	16.83	1.93
Verbenyl ethyl ether	3.45	3.27	24.43
α -terpineol	1.51	3.80	9.03
Geranyl acetate	1.38	1.53	0.25
β -caryophyllene + β -elemene	0.54	0.77	0.93
α -humulene	0.33	0.47	0.90
δ and γ -cadinene	0.57	1.15	0.93
Caryophyllene oxide	0.23	0.09	5.13

Table 2. The main volatile compounds (mg/L) identified in gins

3.2 Sensory evaluation

Distilled beverages are complex mixtures of many individual compounds in an ethanol: water matrix. The composition of the distillate drinks depends of the raw material (grain or fruit) and also of the technology employed in its elaboration (mashing, fermentation, distillation and maturation). In some beverages as gin the composition depends of the flavouring agents added to a neutral alcohol. The unique recipe used by the producers implies a different sensory profile in these beverages. Particularly, in the gin technology it is well known that the distillation process at low temperatures (near 0°C) could benefits the retention of volatile compounds as oxygenated monoterpenes and a decrease of monoterpenes. This fact could imply high stability (Greer, et al., 2008). Even though gin is one of the most consumed around the world, the knowledge about its sensory profile is limited. Only few studies exist about the sensory profile of gin, there are detailed in Table 3. Table 3 also showed the number of attributes identified in gin in the works published.

Piggott and Holm (1983)	21 attributes
Mc Donell et al., (2001)	2 attributes
Phelan (2004)	16 attributes
Riu-Aumatell et al., (2008)	5 attributes

Table 3. The studies founded in the literature about the sensory profile of gin

The quality of spirituous beverages could be defined by a small number of attributes (colour, aroma, taste and mouthfeel). Today, the tasting and nosing of distilled beverages remains very important in the distilleries. Actually a panel of trained judges are used replacing a single expert. The tasters have two clear objectives, for one hand the ability to identify each individual attribute in the whole flavour and at the same time develop a list of vocabulary. In order to obtain a consistent list of attributes, a reference material must be available which allow to the panellists to identify a reference material to a descriptor. As can be seen in Table 3, for juniper flavoured beverages doesn't exist a unified vocabulary and at

the same time any sensory wheel. Except the juniper flavour also than citric the variability about the list of terms that defined gin is high. For this, each author elaborate its own list of vocabulary and they trained the panel according to the objective of the study. The variability about the training, or the botanicals or standards used in the training is high. Based in our experience, in order to obtain an optimum list of attributes a high training of the panellists is necessary. Moreover, it must be necessary to have materials, standards with optimum quality useful for the training of the panellists.

According to Simpson et al., (2004) there are three guides about the vocabulary development:

- Use one flavour for every word
- Use the smallest the sensory vocabulary consistent with sensory description task
- Avoid subjective terms (good/bad)

In the own study about sensory profile of gin we have a double objective. For one hand, establish a sensory characterization of gins and to do this was absolutely necessary firstly elaborate a vocabulary. To perform the work the lexicon development was performed according to the ISO 11035 and a Generic Descriptive Analysis was applied to 4 London Dry gins and two gins with geographical indication.

The panellists were 7 women and 7 men of the Nutrition and Food Science department of the University of Barcelona. All of them are selected according to the availability, health aspects and their experience on tasting food and alcoholic beverages. First a triangle test was performed to check differences between the gins tested. At the same time this test is useful to familiarize the panel with the gin samples. Then the generation of vocabulary was performed during four sessions detailed in Table 4.

1 st session	Intensity ranking test Hydro alcoholic solution of myrcene, limonene, linalool and γ -terpinene
2 nd session	Description and recognition of orthonasal perception Natural sensory references: juniper, coriander, aniseed, lemon peel
3 rd session	Vocabulary generation Elaboration of a preliminary list with 44 terms Discussion with the panel leader Elaboration of a first list with 10 attributes (juniper, coriander, liquorice, spice, fruity, floral, citric peel, cardamom, aniseed/fennel, angelica root)
4 th session	Intensity Ranking test Gin enriched with ethanolic extracts of juniper berries, aniseed and coriander seeds and angelica root

Table 4. The training sessions performed during the descriptive analysis of gin

The descriptors selection was performed according to the ISO 11035. The generic descriptive analysis (GDA) was performed in successive sessions to avoid the fatigue of the assessors. Also, the alcoholic strength was diminished in order to avoid fatigue and also, to equal the alcoholic strength of the samples. From the 10 first list of descriptors (Table 4) the final attributes were selected using geometric means and Principal Components Analysis (PCA).

The profile sheet used includes an unstructured scale from 0 to 5 (0 is the absence of perception) (Figure 1).

Name of the taster:
Date:
Sample code:

Orthonasal

Juniper

0

5

Citric

0

5

Aniseed

0

5

Liquorice/
Angelica root

0

5

Spices

0

5

Retronasal

Juniper

0

5

Citric

0

5

Aniseed

0

5

Liquorice/
Angelica root

0

5

Spices

0

5

Fig. 1. Profile sheet of organoleptic assessment of gin

From a list of 10 attributes afterwards the vocabulary reduction a final list of 5 attributes was established (juniper, citric, aniseed, liquorice/angelica root, and spice). The generic descriptive analysis of gin samples was evaluated in duplicate in 3 sessions presented in randomized order and coded with three digit numbers. The results obtained are showed in Figure 2. G1-G4 is the mean of the results of 4 London Dry Gin while G5 and G6 are gins with geographic indication.

The results obtained by retronasal perception are similar to that of orthonasal perception (Data not shown). The sensory profile of London Dry gins was different of that of gins with geographical indication. The London Dry gins showed an equilibrated profile with intermediate values of all the descriptors evaluated. While gins with geographical indication were noticeable different. Gin G5 was characterized by citric attribute (probably because the

species added were more citric as cardamom, coriander or citrus peel) while G6 was characterized by juniper descriptor. The high values of citric attribute in G5 and juniper in G6 could mask the detection of other attributes in this samples. The sensory profile could be related with sensory profile (Table 2). The results of sensory analysis are in accordance with that of chemical composition (Table 2).

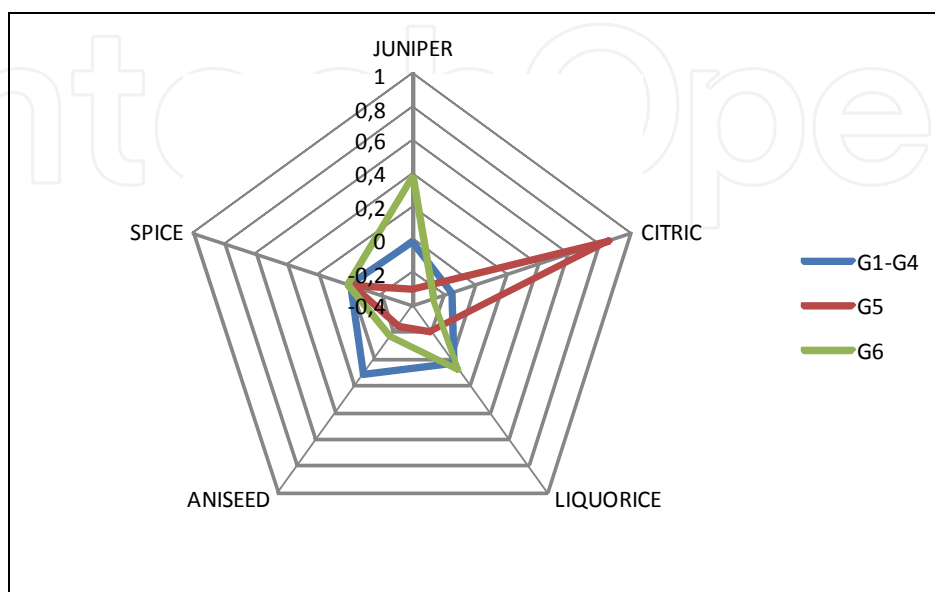


Fig. 2. Aroma profiles of gin samples obtained by orthonasal perception

4. Conclusions

In the last years the use of sensory analysis as quality control in the industry has increase its use. Some sensory methods as difference methods (particularly difference from standard) and descriptive methods are showed its usefulness in a wide range of industries. Nevertheless, is vital to continue the research in sensory analysis in order to ensure the optimum results. On the other hand methods as affective or preference methods are not useful to take part of a quality assurance program.

The results obtained by our group in the sensory analysis of gin showed as difference test and descriptive analysis could be a good method to evaluate the quality of a distilled beverage as gin. The variability of such samples makes them particularly important to obtain a consensus about the list of descriptors and therefore the training of the panel is especially important. This allows to evaluate the changes or alterations in the production process of alcoholic beverages and to make the appropriate modifications. Also, the results obtained from sensory analysis are in accordance with the results obtained in chemical analysis.

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Wide Spectra of Quality Control

Edited by Dr. Isin Akyar

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Quality control is a standard which certainly has become a style of living. With the improvement of technology every day, we meet new and complicated devices and methods in different fields. Quality control explains the directed use of testing to measure the achievement of a specific standard. It is the process, procedures and authority used to accept or reject all components, drug product containers, closures, in-process materials, packaging material, labeling and drug products, and the authority to review production records to assure that no errors have occurred. The quality which is supposed to be achieved is not a concept which can be controlled by easy, numerical or other means, but it is the control over the intrinsic quality of a test facility and its studies. The aim of this book is to share useful and practical knowledge about quality control in several fields with the people who want to improve their knowledge.

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University Campus STeP Ri
Slavka Krautzeka 83/A
51000 Rijeka, Croatia
Phone: +385 (51) 770 447
Fax: +385 (51) 686 166
www.intechopen.com

InTech China

Unit 405, Office Block, Hotel Equatorial Shanghai
No.65, Yan An Road (West), Shanghai, 200040, China
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Phone: +86-21-62489820
Fax: +86-21-62489821

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