Global Perspectives in Coffee Quality Improvement

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Abstract

Coffee is drunk for pleasure. Its flavor is, therefore, the most important quality criterion; it is the sum of different parameters all coming into play during primary production of green coffee:

♦ Plant genetics, with the choice of variety based on resistance to pests, productivity, morphology, and, not to be neglected, liquor quant characteristics;
♦ Orchard practices, particularly at harvest, when only ripe fruits should be selected;
♦ Primary processing, where the choice between dry and wet processing must depend, not only on local climate, but also on end-use of the product (filter, espresso or soluble coffee).

All the downstream operations (storing, roasting, brewing, etc.) can only preserve cup quality. Besides its flavor characteristics, other factors such as environmental impact, purity, and safety are becoming important for the global evaluation of coffee quality. This paper reviews all these factors (taste testing, measures of physical parameters, chemical and microbiological purity, etc.), and discusses their impact on consumers and regulators in consumer countries.

Keywords: Green coffee, soluble coffee, powder coffee, wet and dry processing, liquor quality, primary processing, filter, espresso, storing, roasting, brewing, flavor, environmental impact, purity, roasted and ground brews, cup quality.

Introduction

Each year six million tons of coffee are produced, more than 80% to be consumed as roasted and ground (R&G) brews, while a little less than 20% goes into the production of soluble coffee.

Within the roasted and ground coffee are different types of brews, ranging from the crystal clear filter coffee to thick and foamy espresso, 3–4% of total consumption, but fast-growing worldwide. Within the soluble coffees we find liquid coffees, becoming important particularly in the Far East, and powder coffees, picking up a ‘share of the throat’ especially in the tea-drinking countries of the world.

The required quality depends on the use, which does not mean that any coffee should finally find a buyer. Unfortunately this is sometimes the case and poor quality coffee finds its way onto the market.
coffee adds to the body of the liquor, a characteristic appreciated by the fast growing espresso segment. All downstream operations can at best only maintain the liquoring qualities attained by green coffee, never improve or correct them.

Quality for the Roaster

Quality evaluation for the roaster requires:
- reliability of supply
- uniform low moisture and agreed defect count
- regular roasting characteristics
- cup quality.

Quality for the Consumer

Although consumers generally do not possess a refined vocabulary to explain if their likes or dislikes for a particular cup of coffee, which is often either bitter or ‘good’, their consumption patterns are strongly influenced by taste and smell – top quality coffees always find consumers who can afford them.

In the recent years, environmental (green issues), such as organic, fair trade or sustainable coffees have also become criteria of choice for the consumers. These new quality criteria can bring benefits for the planters who receive a guaranteed minimum price, or a bonus for above-standard quality and advice on quality control and market needs. Roasters also benefit by ensuring that the farmers produce coffee according to the required standards, and may sell their product under a special label.

Quality for the Regulator

In the interest of consumer protection, the regulator acts from purity and from safety considerations.

Quality Parameters for the Food Technologist

Many hundreds of the compounds formed at roasting by the chemical interaction between the carbohydrates, chlorogenic acids, amino acids and other reactive compounds present in the green bean have been identified. Differences are minor, mainly quantitative, and the complete chemical profile, cannot be used to explain why one coffee gives a better cup than another (Viani 2000).

Aroma

The most important parameter in the appreciation of quality is the organoleptic quality of the cup, mainly due to the volatile substances present, accounting for no more than 0.1% of the total, while non-volatile components can only explain acidity and bitterness (Vitzthum 1998).

Among the many hundreds of components discovered in the aroma complex (most of which are unimportant for flavor), the active smelling compounds have now been identified by sniffing all the components coming out of the column outlet of a gas-chromatograph (Fig. 1). The most intense smelling components – the majority already present in green beans, may then be identified by successive dilutions of the aroma until only a few can still be detected (Table 1).
Table 1. Main odorants in a coffee brew (µg/l)

<table>
<thead>
<tr>
<th>Aroma</th>
<th>Arabica</th>
<th>Robusta</th>
<th>Threshold in water</th>
</tr>
</thead>
<tbody>
<tr>
<td>(E)-ß-damascenone*</td>
<td>1.3</td>
<td>1.5</td>
<td>0.00075</td>
</tr>
<tr>
<td>3-mercapto-3-methylbutylformate</td>
<td>5.5</td>
<td>1.5</td>
<td>0.0035</td>
</tr>
<tr>
<td>2-furfurylthiol</td>
<td>19.1</td>
<td>39.0</td>
<td>0.01</td>
</tr>
<tr>
<td>Methanethiol</td>
<td>210</td>
<td>600</td>
<td>0.2</td>
</tr>
<tr>
<td>3-methylbutanal</td>
<td>550</td>
<td>925</td>
<td>0.35</td>
</tr>
<tr>
<td>Methylpropanal</td>
<td>800</td>
<td>1350</td>
<td>0.7</td>
</tr>
</tbody>
</table>

* It may contribute to the process flavor of soluble coffee.

The same technique helps in identifying the off-flavors that, if present even in extremely minute amounts, spoil cup quality (Table 2).

Table 2. Main off-flavors of coffee

<table>
<thead>
<tr>
<th>Off-flavor</th>
<th>Responsible chemical(s)</th>
<th>Threshold in water (µg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medicinal, ‘rioy’</td>
<td>2,4-6-trichloroanisole</td>
<td>0.001</td>
</tr>
<tr>
<td>Earthy, robusta</td>
<td>(-)2-methylisoborneol*</td>
<td>0.0025</td>
</tr>
<tr>
<td>Musty</td>
<td>Geosmin</td>
<td>0.005</td>
</tr>
<tr>
<td>Fruity, rotten, stinker</td>
<td>Ethylesters of 2-3-methylbutanoic and cyclohexanoic acids</td>
<td>5,000-10,000</td>
</tr>
</tbody>
</table>

* (-)2-methylisoborneol represents some 60-70% of the characteristic robusta flavor (Vitzthum et al. 1990), and a patent to reduce its content to below its threshold level has been taken (Becker et al. 1989).

All these compounds are probably of microbiological origin, and are already present in the green bean.

A technique which proves very useful in the evaluation of new processes, particularly in soluble coffee manufacture, indicates the flavor evaluation by a trained test panel in the form of a star diagram, where notes like burnt, cooked, fruity are profiled semi-quantitatively. The sample analyzed in Fig. 2, has been
characterized by the panel, as possessing an intense overall aroma and flavor, a roasted/burnt/smoked note, and a stale/oxidized off-flavor.

Quality Parameters for the Roaster

The European Contract for Coffee states that, “all goods contracted for shall be of sound merchantable quality....” A new version of the contract, including a reference to excessive moisture as not being in conformity with the quality requirements, is under study by the European Coffee Trade Federation (Anon. 1997a).

Both analytical (moisture, defect count) and organoleptic (taste testing) criteria are available and are used by the roasters for the choice of the green coffee qualities they use in their blends:

- Specialty coffee roasters, espresso in particular, need special qualities (e.g. body from top dry-processed arabicas, absence of immature beans, which make the cup astringent and metallic);
- Major roasters need large quantities of reliable constant good quality coffees, particularly robustas.

**Moisture:** Several different ISO standards are available for the measurement of moisture. They do not all give the same results, thus contradicting the idea of standardization. In the last meeting of ISO TC34 (Agriculture) SC 15 (Coffee) (Anon. 1999a), it has been agreed:

- to select among the methods already available the most suitable to be used as reference;
- to standardize a rapid method, based on devices, such as Sinar, Dickey-Jones or Dole, which have become common in the trade.

**Defect Count:** Many different grading systems are used in the trade of coffee and at the last meeting of ISO TC34 (Agriculture) SC 15 (Coffee) a revision of ISO 10470, simplifying it, was proposed (Anon. 1999a):

- by considering together both dry and wet processed arabicas and robustas
- by classifying defects according to their incidence (1) or (0) on the organoleptic profile of the cup, and on the economic aspects;
- by indicating if the defect is serious (s), so that it could be applied generally in the trade.

The weight of each defect is also being reassessed in the light of new information available, and the following defects are now considered as serious:

- **Organoleptically** – beans that are black, partly black; dark brown, amber, with foxy silverskin, sour, stinker, spotted bean; pergamino, bean in pergamino; pod, husk fragment; moldy bean.
- **Commercially** – bean fragments, bean in parchment; large, medium, small sticks; large, medium, small stones; soil agglomerates; foreign matter.

That new criteria must be considered in the evaluation of defects has also been agreed by the London International Financial Futures and Optional Exchange (LIFFE) classification of robustas (Anon. 1999b), stating that “…coffee is not tenable if:

- it has more than 450 defects per 500 g;
- it is unsound;
- it contains more than 10% passing through a round screen 12;
- in respect to a lot graded (effective from 1 February 2000), it has more than five fully moldy or ten partially moldy beans in combination thereof, such that the total exceeds the equivalent of 5 fully moldy beans per 500g.”

**Liquoring:** The techniques of organoleptic evaluation, useful in the development of new processes, would be too cumbersome for the roaster wishing to ensure routinely the wholesomeness of the raw material used. A simple and clear vocabulary is in general sufficient to a trained expert panel in the day-to-day liquoring routine:

For arabica, flavor can be defined as the sum of *aroma* plus *acidity* plus *body*, where:

- flavor is the taste of a sound, clean arabica coffee, not the level of roastiness;
- aroma is the smell of a sound, clean, freshly brewed arabica coffee;
• acidity is a sharp and pleasing taste as opposed to a sour taste, which may indicate signs of fermentation. Acidity is best appreciated in a low roasted filter coffee;
• body is the viscosity, fullness and weight in the mouth, ranging from thin and watery to thick and heavy. It is an important characteristic particularly in espresso coffee, where it is associated with a good body, as shown by the comparison of a correctly prepared cup with a poorly prepared one when using the same blend.

The panel must also recognize a few undesirable flavors and all off-flavors, such as:
• undesirable flavors of arabica – green/grassy, cereal/woody/papery, baggy;
• off-flavors of arabica – chemical/medicinal, hard/metalllic, earthy, fermented, moldy/musty.

The flavor of a robusta must be neutral/bitter, and devoid of woody and rubbery notes.

Undesirable/off-flavors of robusta are: green/grassy, chemical/medicinal, and earthy, fermented or moldy/musty.

The organoleptic profile is usually obtained by one of two techniques:
• by oral agreement within an expert tasting panel after open discussion; this technique is the most effective if the aim of the panel is to identify the top quality coffees;
• by the average of independent results (either blind or by comparison with a reference), of members from the tasting panel. This technique is useful for maintaining a good constant average quality in industrial production.

Quality Parameters for the Regulator

Purity: Lack of physical criteria, such as defect counting, has hindered the objective evaluation of soluble coffee, particularly when imported from producer countries, where no control of stocks could be easily achieved, and only taste testing could give some indication of the quality of the product.

Findings, showing that there was a precise carbohydrate fingerprint for pure soluble coffee (Blanc et al. 1989), led to the establishment of an ISO analytical standard (Anon. 1997b), and to national Codes of practice in the United Kingdom (BSCPIA/BSCMA 1995) and France (Syndicat Français des Fabricants de Café Soluble 1999), which, by indicating maximum acceptable levels of certain carbohydrates, have helped in reducing the import of adulterated products into the European Union (Table 3).

Table 3. Tolerable control limits for carbohydrates in soluble coffee

<table>
<thead>
<tr>
<th>Indicator carbohydrate</th>
<th>Maximum content in pure coffee (%)</th>
<th>Control limit (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total glucose</td>
<td>2.1</td>
<td>2.6</td>
</tr>
<tr>
<td>Total xylose</td>
<td>0.4</td>
<td>0.6</td>
</tr>
<tr>
<td>Free fructose</td>
<td>0.6</td>
<td>1.0</td>
</tr>
</tbody>
</table>

The question of soluble coffee purity has become particularly important in Eastern Europe after the opening of the markets in the 1990s, and must still be solved, particularly after a link between relatively high contents of ochratoxin A (see following section), and adulteration has been found. (Pittet et al. 1996).

Safety

The possible presence of contaminants, such as pesticides (McCarthy et al. 1991), polycyclic hydrocarbons formed at roasting (Maier 1991), or paraffins from the coffee bags (Grob 1991), have at various time alerted authorities until analytical data were made available indicating that the safety problem had been solved.

Mycotoxins, ochratoxin A in particular, (a nephrotoxic and carcinogenic substance), may be formed during cherry processing, storage or transport of the beans, if moisture is uncontrolled, and will still be present in the cup (van der Stegen et al. 1997), even if it is partially destroyed during roasting (Blanc et al.
1998). A multi-center project is active to solve this new challenge (Anon.1999b).

Conclusion

Both fine organoleptic and analytical criteria are now available and are used in the following ways by roasters in the selection of the coffee types used in their blends:

- Specialty coffee roasters, espresso producers in particular, need special qualities, such as a rich body from the best dry-processed arabicas, and the absence of immature beans, which make the cup astringent and metallic.
- Major roasters need large quantities of reliable supplies of constant, good quality coffee, particularly robustas.

Regulators need to be assured that the product entering the market is neither adulterated nor contaminated.

Finally, consumers wish to drink a good, not bitter cup, which they can recognize even if they may have difficulties in describing it!

References

McCarthy, J.P. et al. (please give all names) 1991. 14th ASIC, San Francisco, 175.
Vitzthum, O.G. 1998. Thirty years of coffee chemistry research. Annual Meeting of the ACS, Boston, MA, USA.