

## **Title**

**Sensory attributes of coated tablets: developing a formal lexicon and sensory wheel**

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## **Abstract**

The patient's sensory experience when taking an oral medicine is important in the assessment of its palatability, and acceptability.. The aim of this study was to develop tools useful for standardization of sensory assessment of coated tablets: a lexicon and a sensory wheel.

Two randomised, double-blind sensory assessments were performed involving 83 and 52 healthy adult volunteers and two sets of coated tablets. By adapting the principles used by food sciences, a free-text description of conventional, bitter-tasting or tasteless, coated tablets was performed. In the first assessment, volunteers described the sensory attributes of the first set of tablets. The attributes collected were then validated using a second set of tablets in a separate study with different volunteers. The appropriateness and semantics of each sensory attribute was analysed. Twenty-two attributes most relevant for assessment of coated tablets were selected for the lexicon and associated with explicit definitions. A collection of all attributes that could possibly be triggered by coated tablets were organised in the form of a sensory wheel. This study provides a valuable insight into the sensory experience while taking a coated tablet, and presents tools which can accelerate the development of palatable medicines.

## 1 Introduction

Little is known about the sensory attributes of pharmaceutical formulations and how these influence product acceptability. The acceptability of any medicine to a patient is a determinant of adherence. Acceptability is defined as “the ability and willingness of a patient to self-administer, and also of any of their lay or professional caregivers, to administer a medicinal product as intended”, and acceptability studies within the intended target population are a regulatory requirement (EMA, 2013; EMA, 2017). A patient’s acceptance of an oral medicine is a complex mix of practical and psychological considerations. On a practical level, acceptability relates merely to the ability to successfully take a medicine. Psychologically, the sensory (and physical) attributes (e.g. taste, smell, surface and bulk texture, mouthfeel, colour, size, shape) of the medicine have an important influence on palatability and a patient’s willingness to take their medicine (European Medicines Agency, 2013). Despite the complex nature of acceptability, the attributes most commonly measured during oral medicine development are taste and overall palatability (Thompson *et al.*, 2013). Few studies investigate multiple sensory attributes of oral medicines and their influence on overall palatability and subsequent acceptability.

Pharmaceutical sensory research is an emerging area of interest. Sensory research uses human panels to measure sensory perception and generate a quantitative objective product description. The overall sensory perception of a product is a combination of stimuli that interact with different receptors, e.g. chemoreceptors, thermoreceptors, mechanoreceptors. With the help of sensory testing, the complexity of sensory perception can be broken down into individual components, i.e. sensory attributes.

A lexicon, which provides lists of attributes relevant for sensory assessment with precise, unambiguous definitions of the sensory experiences triggered by a product, is fundamental to sensory assessment (Dubois, 2006). The use of precise, unambiguous definitions ensures that the lexicon generated is meaningful to those involved in testing. For food products, lexicons of sensory attributes have been developed and validated for particular product groups (e.g. cashew nuts or soy sauces). These clearly defined sensory attributes can be further interrogated using a method called descriptive sensory analysis, where each attribute is scaled to provide qualitative and quantitative measures of intensity (Murray, Delahunty and Baxter, 2001). Such scaling uses defined products chosen to be representative of the scale extremes (i.e. intensity reference products). For example, gelatine dessert, potato chip and thin bread wafer can be used to anchor low, medium and high levels of roughness respectively (Lawless and Heymann, 2010b).

Sensory lexicons can be further refined into a sensory wheel; a comprehensive collection of the sensations that could be triggered by a product. They are often representative of an entire product category (e.g. the coffee wheel) and sometimes divided by sensation (e.g. white wine has a separate aroma and mouthfeel wheel) (Lawless and Civille, 2013). Within the wheel, sensory attributes are categorised (e.g. by stimuli or flavour) and arranged hierarchically. This provides an overview of a product’s sensory attributes and facilitates

systematic assessment (Imamura, 2016). Sensory lexicons can be used as a communication tool to guide a product's development, while sensory wheels are widely used to define taste, flavour and other detailed characteristics of a product. Combined with consumer feedback, sensory assessment provides an opportunity to relate how much a product is liked to its sensory attribute profile (Suwonsichon, 2019). Developing sensory lexicons and wheels for oral medicines has the potential to provide a tool to standardise the description of a product's sensory attributes thereby informing its palatability and acceptability

In food *in vivo* testing, there is a clear distinction between, sensory science which uses a trained panel of individuals to test and describe the product, and consumer science, which uses a large group of consumers to do so (Yang and Lee, 2019). Further, sensory science panels measure perceptions of sensory stimuli and generate an objective product description, while consumer science panels measure hedonic reactions and subjective opinions (Yang and Lee, 2019). This approach is not translatable to pharmaceutical sensory testing. Firstly, due to a lack of sensory panels trained for pharmaceutical products, and secondly as the target patients may not be accessible or numerous enough. Moreover, patients as the target population are distinct from a food consumer, in that they can have morbidity-affected senses and thus have different acceptability requirements. As a result, in pharmaceutical sensory science, the group of choice are usually healthy adult volunteers.

Pharmaceutical products are designed to trigger an acceptable sensory perception, rather than a pleasing one (EMA, 2013). In pharmaceuticals, sensory studies provide information about the attributes that can compromise or ensure acceptability, whereas in food science sensory studies are carried out to explore the richness of the flavours and texture of the product. Secondly, pharmaceutical dosage forms are designed to be acceptable to widest possible population, while sensory studies in food industry can also aim to develop a unique product to satisfy niche population of consumers (Stone, Bleibaum and Thomas, 2012).

. The aim of this study was to explore the sensory attributes of conventional coated tablets, as an example of a typical oral solid dosage form (OSDF), in order to develop a sensory lexicon and wheel representative of this product group. To do this, the principles used for sensory analysis of food products were adapted and applied to a set of bitter tasting tablets and a set of tasteless tablets, each with a range of different coatings.

## **2 Materials and methods**

### **2.1 Tablet samples**

Developing a lexicon and sensory wheel requires the use of a diverse set of samples in order to capture all potential sensory attributes (Koch *et al.*, 2012). A total of nine placebo formulations were chosen to provide a range of tasteless and bitter-tasting tablets with different coatings. All tablets were designed to be swallowed with water rather than chewed or retained in the mouth (conventional tablets).

Two sets of conventional tablets were used: oval T<sub>A</sub> and round T<sub>B</sub>. The set of T<sub>B</sub> tablets contained quinine, 2.5% (w/w), as a bitter tasting agent. Both sets of tablets were film coated, the film compositions are listed in Table 1. All tablets were manufactured to allow human consumption. T<sub>A</sub> tablets were manufactured by VerGo Pharma Research Laboratories Ltd., T<sub>B</sub> by Chrysalis Health & Beauty Ltd. All tablets were white.

Table 1 List of formulations used in the study.

	Formulation	Tablet coating description	Coating ingredients	Final coating level (w/w)*	Tablet core
First set of tablets	T <sub>A</sub>	Uncoated	-	0%	Oval, tasteless
	T <sub>A</sub> Coat-1	Standard commercial	Opadry® 03F mix (HPMC-based)	3%	Oval, tasteless
	T <sub>A</sub> Coat-2	Slippery commercial	Opadry® EZ Swallow white (HPMC-based + hydrocolloid gum and MCT)	3%	Oval, tasteless
	T <sub>A</sub> Coat-3	Slippery commercial	Opadry® EZ Swallow white Opadry® EZ Swallow clear (HPMC-based + hydrocolloid gum and MCT)	3% + 1%	Oval, tasteless
Second set of tablets	T <sub>B</sub> Coat-4	Standard reference	HPMC 5, glycerol	4%	Round, bitter
	T <sub>B</sub> Coat-5	Lipid based	Lubritab®, Capmul® MCM, HPMC 5, talcum, titanium dioxide	4%	Round, bitter
	T <sub>B</sub> Coat-6	Slippery	HPMC 5, xanthan gum, glycerol, talcum, titanium dioxide	4%	Round, bitter
	T <sub>B</sub> Coat-7	pH dependent	Eudragit EPO readymix, titanium dioxide	4%	Round, bitter
	T <sub>B</sub> Coat-8	Insoluble – soluble polymer	HPMC 5, Surelease®, glycerol, talcum, titanium dioxide	4%	Round, bitter

\*as declared by manufacturer

HPMC – hydroxypropyl methyl cellulose

MCT – medium chain triglycerides

## 2.2 Lexicon and sensory wheel development pathway

The sensory attributes of the coated tablets were collected as part of two separate studies Hofmanová *et al.* (2019) and Hofmanová *et al.* – manuscript in preparation). The sensory panels for both studies were healthy untrained adults between the ages of 18 and 75 years. The first study, assessing the T<sub>A</sub> set of tablets, used a panel of 83 participants, resulting in total of 332 evaluations. The second study assessed the T<sub>B</sub> set of tablets and used a different panel of 52 participants, resulting in total of 260 evaluations. Figure 1 presents the lexicon development pathway used.

### 2.2.1 Generating an initial list of attributes (Step 1)

The first sensory study generated an initial list of attributes relevant for the product (Figure 1, Step 1). One uncoated and three coated tasteless tablets (T<sub>A</sub> tablets) were presented to participants in a randomised order to reduce sequential bias. Participants were instructed to hold each tablet, one at a time, in their mouth for 10 seconds, feel its surface with their tongue and then spit out or swallow the tablet according to their preference. Immediately after each tablet, participants were asked to “describe in three words how the product feels in the mouth” using free text. Between each tablet, participants were given a palate cleanser to eliminate carry-over effects. The palate cleanser comprised drinking spring water at room

temperature followed by a piece of lightly salted cracker (Jacob's, or Schar gluten free) then water again (Lucak and Delwiche, 2009).

### **2.2.1.1 Refining the initial list of attributes – data cleaning (step 2)**

To clean the data, participant "free text" descriptions were transcribed, unified grammatically, and shortened without any change of meaning (Kumar and Chambers, 2019). Qualifiers (e.g. *little, slightly*) and illegible responses were disregarded (ISO, 1994). The appropriateness and semantics of each attribute were then analysed. Attributes with redundant, vague meanings or non-existent words were excluded. Also hedonic attributes (e.g. *pleasant, bad*) were excluded as not relevant for sensory assessment (ISO, 1994). Ambiguous attributes (e.g. *clear*, which could express different meanings, such as *clean, plain, or transparent*), were excluded to reduce the risk of misinterpretation. The resultant list of attributes (list A) was taken forward for validation.

### **2.2.2 Validation (step 3)**

In a second separate study, the set of T<sub>B</sub> tablets was subject to a sensory assessment panel using the same methods as for the set of T<sub>A</sub> tablets (section 2.2.1). However, in this study participants were presented with five coated tablets, containing a bitter tasting agent (quinine), in a randomised order. In addition, when asked to "describe in three words how the product feels in the mouth" (free text), participants were given the choice of list A attributes and/or their own words.

According to several authors, the attributes which should be included in a lexicon are those generated in the highest frequency (Henley, 1969; Szczesniak and Kahn, 1971; Antmann *et al.*, 2011). Six key attributes of tablets (*sticky, smooth, rough, slippery, bitter and aftertaste*) were automatically included in the lexicon. The first four were included as they were most abundant in the first study (over 40 mentions) and the last two because they were considered innate to the quinine content of T<sub>B</sub> tablets. The frequency of attributes chosen from list A was then considered. Any attribute chosen six or more times (i.e. used by more than 10% of participants (Antmann *et al.*, 2011)) was regarded as relevant to describe coated tablets and therefore also considered "validated" generating list B.

### **2.2.3 Refining the validated list – term reduction (step 4)**

Validated attributes (list B) together with the key attributes were further refined on the premise that the number of attributes required for efficient sensory evaluation, and hence inclusion to the lexicon, is about 20 (Vannier, Brun and Feinberg, 1999). Attributes with opposing meanings and intensity descriptions were reduced to a single attribute. Synonyms were deleted. Where relevant, lay vocabulary was replaced with more pharmaceutical terminology e.g. *fall apart* was changed to *disintegrating*. The resultant list of attributes was included in the lexicon.

### **2.2.4 Generating a lexicon (step 5)**

Explicit definitions were established for the final list of attributes based on published literature. Attributes were then grouped into conceptually related categories analogous to food science research (Drake, Yates and Drake; Kim *et al.*, 2013; De Pelsmaeker *et al.*, 2019).

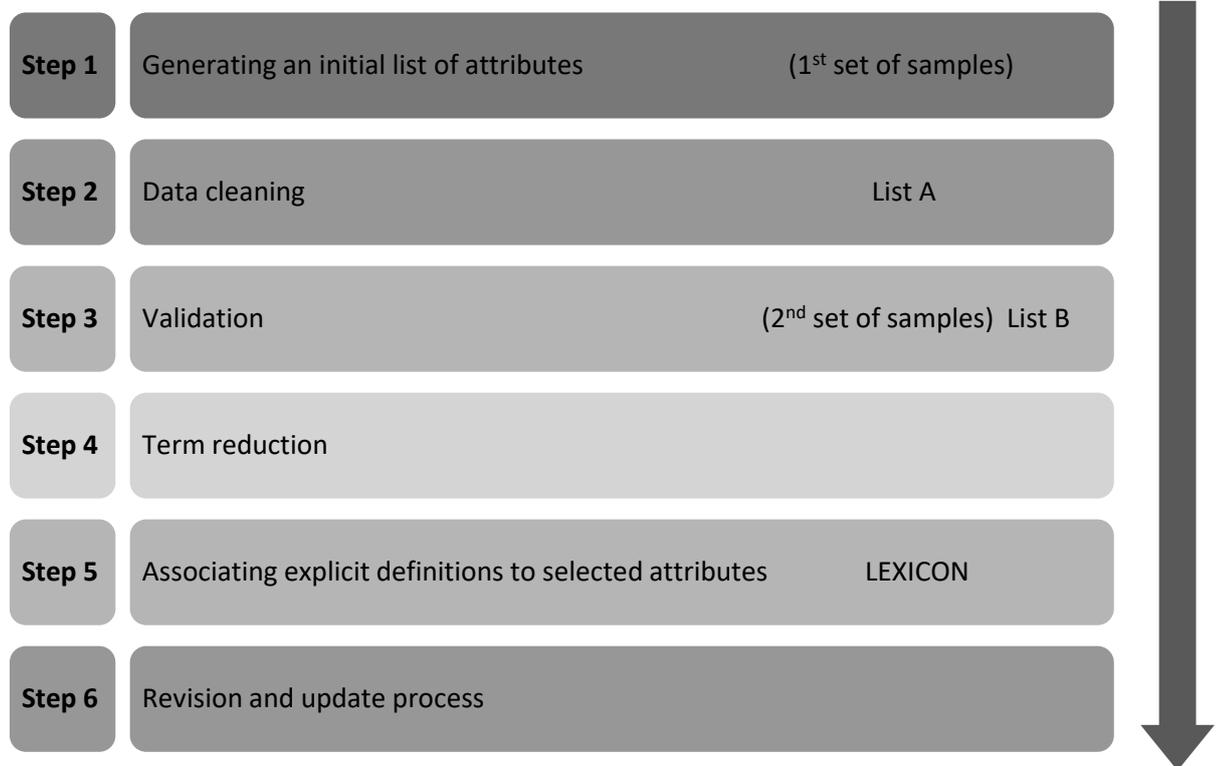


Figure 1 Process of building a lexicon for tablets; Step 6 is a prospective process (not reported in this preliminary study).

### 2.2.5 Generating a sensory wheel

A sensory wheel was generated by collective analysis of the attributes collected from both tablet sets. From the first study attributes on the list A were included. From the second study, newly generated attributes (i.e. those generated by free text responses which were not on List A) were subjected to the same data cleaning process as conducted in study one (section 2.2.2.1). The attributes obtained, were grouped into categories based on the stimuli involved in the perception of each attribute. Five categories were used: touch, taste, vision, motion, and others. A motion category was created to gather attributes referring to movement of the tablet or changes associated with the tablet during assessment. The sensory wheel was generated using XLSTAT software version 2019.4.1 (Addinsoft).

## 3 Results

### 3.1.1 Generating attribute lists

Free-text descriptions in these studies used consumer-based language. Participants generated 883 comments with the tablet set from the first study ( $T_A$ ). Data cleaning left 98 sensory non-repetitive attributes (Table 2). Exclusion of the most abundant terms which were

considered automatically validated (i.e. those related to *stickiness, smoothness, roughness* and *slipperiness*) and removal of the terms being innate to quinine (i.e. those related to *bitterness* and *aftertaste*) generated list A, consisting of 74 attributes (Table 3). In the second study, where list A was used as a participant prompt, a total of 730 comments were generated (Table 2). Of the list A attributes, 41 of the 74 were frequently chosen (over 6 times) and hence considered validated (Table 3), and a further 25 attributes were generated. For both studies, responses varied from single words (e.g. *smooth*) or even exclamations (e.g. *Ugh*) to full sentences (e.g. *didn't think it would ever dissolve if I couldn't swallow it*). A full list of participant comments is available in Appendix 1.

Table 2 Frequency of collected participants' comments and attributes.

	Number of cases	
	First study	Second study
All comments	883	730
Valid comments*	806	719
Varying non-repetitive attributes	128	111
Hedonic attributes	30	17
Sensory attributes	98	94
Shared sensory attributes		69
Unique sensory attributes	29	25

\*nonsensical and illegible comments excluded

Table 3 List A: Seventy-four attributes from the first tablet set ( $T_A$ ) with frequency of occurrence from the second tablet set ( $T_B$ ); shaded area - List B: forty-one most frequently used attributes (i.e. validated attributes).

<i>neutral</i>	35	<i>dusty</i>	11	<i>floury</i>	6	<i>gooey</i>	1
<i>chalky</i>	30	<i>light</i>	11	<i>soft</i>	6	<i>minty</i>	1
<i>dry</i>	26	<i>plastic</i>	11	<i>thick</i>	6	<i>pointy</i>	1
<i>solid</i>	25	<i>doesn't fall apart</i>	10	<i>pasty</i>	5	<i>spongy</i>	1
<i>chemical</i>	24	<i>doesn't melt</i>	10	<i>artificial</i>	4	<i>aniseedy</i>	0
<i>movable</i>	20	<i>glazed</i>	10	<i>gooey</i>	4	<i>big</i>	0
<i>moves easily</i>	19	<i>silky</i>	10	<i>melts</i>	4	<i>disintegrating</i>	0
<i>rounded</i>	19	<i>alkaline</i>	9	<i>not movable</i>	4	<i>falls apart</i>	0
<i>bland</i>	18	<i>clingy</i>	9	<i>shiny</i>	4	<i>fizzy</i>	0
<i>plain</i>	18	<i>grainy</i>	9	<i>solvent taste</i>	4	<i>fluffy</i>	0
<i>small</i>	18	<i>no flavour</i>	9	<i>creamy</i>	3	<i>furry</i>	0
<i>matte</i>	17	<i>dissolving</i>	8	<i>granular</i>	3	<i>gelatinous</i>	0
<i>synthetic</i>	16	<i>gluey</i>	8	<i>gritty</i>	3	<i>glutinous</i>	0
<i>unnatural taste</i>	16	<i>no edges</i>	8	<i>not tacky</i>	3	<i>large</i>	0
<i>slick</i>	15	<i>doesn't dissolve</i>	7	<i>starchy</i>	3	<i>mushy</i>	0
<i>powdery</i>	13	<i>mobile</i>	7	<i>adherent</i>	2	<i>pliable</i>	0
<i>clean</i>	12	<i>slimy</i>	7	<i>bumpy</i>	2	<i>soggy</i>	0
<i>hard</i>	12	<i>tacky</i>	7	<i>loose</i>	2		
<i>no taste</i>	12	<i>tasteless</i>	7	<i>crumbly</i>	1		

### 3.2 Generating a lexicon

Of the validated list of 41 attributes (Table 3) and 6 selected key attributes (*sticky, smooth, rough, slippery, bitter* and *aftertaste*), 20 (as recommended by Vannier et al. 1999) were selected for lexicon inclusion and defined (Table 4). Of these, 10 were related to texture, 3 to taste, 1 to flavour, 2 to visual perception, 3 to change-of-state of the tablet, and the remaining 1 was not classified. In food sciences, it is a standard practice to assign one or more reference products to each attribute to indicate an intensity scale (Lawless and Civille, 2013). However, there is minimal knowledge of adequate reference products or appropriate intensity ranges for OSDFs. These factors coupled with ethical considerations regarding the use of actual medicines as reference products meant that no reference products were assigned in this study.

Table 4 Tablet lexicon with sensory attribute definitions. Definitions were based on [1] ISO standard, textbooks [2] Meilgaard, Carr and Civille (2006), [3] Lawless and Heymann (2010a), [4] Cambridge English Dictionary (2019) or other lexicons [5] Civille et al. (2010), [6] Kim et al. (2013), NA - not available.

Attribute	Definition	Ref
<b>Texture</b>		
Chalky	Associated with chalk, dry sensation in the mouth	[2]
Dry	Free from moisture or liquid, perception of moisture being absorbed by product	[1], [4]
Powdery	Amount of fine particles on the surface or as bulk product	[5]
Slippery	Degree to which sample slides across the tongue/palate	[2]
Adhesiveness	Degree to which the sample adheres to mouth surfaces: lips, tongue, palate, teeth (with increasing intensity level: tacky, clinging, gooey – gluey, sticky – adhesive)	[1]
Slimy	Covered in a sticky, smooth, liquid substance, as liquid covering snails	[4]
Smooth	Having regular/even surface, lack of lumps or abrasive particles	[2]
Rough	Degree of irregularity/unevenness of the product's surface; assessed by rubbing the surface	[5]
Granularity	Containing particles/granules detected by assessed by rubbing product between tongue and palate (with increasing intensity and particle size: smooth, gritty, grainy, beady, granular, coarse, lumpy)	[1]
Hard	Force required to compress/break the sample	[1]
<b>Taste</b>		
Bitter	Innately aversive basic taste sensation characteristic to caffeine	[1]
Tasteless	Having no taste, lack of chemical stimulation of taste buds	[4]
Aftertaste	Taste or odour sensation that occurs after the elimination of the product	[1]
<b>Flavour</b>		
Chemical	Flavour associated with artificial products	NA
<b>Visual perception</b>		
Size	Relative description of size (small – large)	[4]
Gloss	The tendency of a surface to reflect light (shiny – matte)	[1]
<b>Change-of-state</b>		
Dissolving	Degree to which the core of the sample dissolves in contact with saliva	NA
Disintegrating	Degree to which the core of the sample breaks up into small parts in contact with saliva	NA

Solid	Keeping a clear shape, object without any spaces or holes, integrity of shape	[2]
<b>Other</b>		
Neutral	Lack of dominant or noticeable characteristics	[1]

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### 3.3 Sensory wheel

The attributes collected in both studies, after data cleaning, were grouped into categories based on the type of stimuli, and presented in the form of a sensory wheel (Figure 2). Five categories were used: touch, taste, vision, motion, and others. Attributes perceived by touch were further organised into groups related to product surface, structure, and hardness of the tablet. Due to their relative abundance, attributes describing varying levels of stickiness were assigned a separate group. In a sensory wheel, the most general attributes are placed at the interior, and more specific at the exterior.

Participants reported a sensation of four out of five basic tastes; only umami was not represented. Even though tablets contained no additional flavours, some responses mentioned a *minty* or *aniseedy* flavour. Several attributes describing the visual perception of the tablets were collected, these related to size and surface. None of the participants generated attributes describing smell or hearing perception. Some participants reported that the tablet underwent a change of structure in the mouth (e.g. *disintegrate*, *dissolve*, and *melt*). These were grouped into a motion category.



addition, the tablets were odourless hence there was no olfactory stimulation. Nevertheless, many medicines contain volatile substances, thus the perception of smell is expected for some flavoured or drug containing products.

Sensory perception of tablets is distinct from that of food products. Conventional tablets are swallowed whole as a solid unit hence their oral perception is mainly due to taste and tactile stimuli. Potential taste stimuli of a conventional coated tablet can arise from the coating, active pharmaceutical ingredient (API) or excipients, although taste-masking coatings will reduce the latter two. Tactile stimuli arise from the interaction of the tablet surface (e.g. the coating) with the oral cavity and is likely to have the greatest influence on sensory perception due to the short residence time in the mouth. Although the texture of tablets may seem unnoticeable, the findings from this study demonstrate the opposite. During administration, the tablet is moistened with saliva and its surface sheared by tongue-palate-teeth movement which changes the tablet structure (and tablet coating structure), which alter the sensations perceived by the patient. The characteristics of the tablet coating, therefore, are important; firstly, because they modify the surface properties of the tablet and secondly, due to presence or lack of taste-masking function.

Based on participants' comments, not only the texture itself but also changes in texture over time are identifiable. In fact, participants used several attributes describing tablet structure change, e.g. *falling apart*, *dissolving*. This suggests that sensory analysis for conventional tablets should be performed in a time-dependent manner. To capture taste/texture changes over time, methodology could be adopted from the Temporal Dominance of Sensations (TDS) technique which is well established in food sciences (Varela and Fiszman, 2012). Texture is more likely to be of importance for an orally disintegrating dosage forms (ODTs) than conventional tablets. Indeed, studies have been conducted reporting the changes in intensity of roughness/grittiness over time for these formulations (Douroumis, Gryczke and Schminke, 2011; Kimura *et al.*, 2015; Wang, Hu and Sun, 2017).

## **4.2 Challenges in lexicon development**

This work constitutes the first step to build a formal lexicon for conventional coated tablets (Table 4). According to accepted standards, a full lexicon includes a list of attributes and definitions that describe a product, as well as a set of references that clarify the terminology (Lawless and Civille, 2013). However, certain difficulties arise when developing a lexicon for pharmaceutical sensory analysis. Firstly, there are gaps in knowledge regarding the textural attributes critical to patient palatability, and therefore acceptability for SODFs. Secondly, the lack of diversity in the sensory attributes of pharmaceutical products, leads to difficulties in obtaining a reference intensity scale. Furthermore, obtaining appropriate reference products for SODFs may be complicated by the need for good manufacturing practice (GMP) or at least human consumption standards of production as well as the ethical burden to participants. However, this issue would be mitigated if a placebo reference set were developed and mass produced as industry standard references.

The vocabulary collected in this work was used to map the participant sensory perception of coated tablets. The analysis showed that the texture vocabulary used to describe tablets is

rich but not standardised. For example, a feeling of fine particles on the tablet surface was described using different attributes i.e. *chalky, floury, powdery, and dusty*. In addition, various attributes can build intensity scale of specific property, i.e. adhesiveness, ordered as: *tacky, clingy, gluey, and sticky*.

The complexity of sensory analysis lies in the language specificity of the individual. In particular, the choice of word depends on the richness of one's vocabulary, and the mother tongue of each participant. Moreover, texture can be characterised differently across the world due to varying food and language cultural references (Varela *et al.*, 2008). The type of words collected might also be compromised where panels of participants are not trained. We hypothesise, that participants used words such as *dissolving, melts, crumbly*, to indicate that tablets disintegrated in the mouth. This suggests (i) that lay participants do not know pharmaceutical jargon (e.g. *disintegrate*), and (ii) clear definition of attributes is necessary for unambiguous communication. Furthermore, using lay participants gave rise to many hedonic attributes not relevant to sensory evaluation. Unlike a panel trained to use only objective attributes, a lay person tends to use simpler language and hedonic attributes in their evaluation (Chollet and Valentin, 2001). For a consumer, hedonic attributes express their feelings rather than an objective description of mouthfeel, for example XXXXX. Although hedonic attributes are not included in lexicons, they may be presented to lay participants as type of words "not to use" in sensory evaluation.

The lack of uniform terminology can impede communication, particularly when the same word is used by one participant to express one sensation and is used by others to express something else. Thus, without presenting a definition of each attribute to the participant, one cannot be sure the exact perception described. A formal lexicon with defined terminology would reduce ambiguities in the interpretation of the sensory analysis of OSDFs.

### **4.3 Practical implications of a tablet lexicon and sensory wheel**

This study identifies sensory attributes not previously reported to be associated with conventional coated tablets. Both the sensory lexicon and wheel developed in these studies have the potential to inform product development and accelerate the evaluation of a SODF's palatability and hence acceptability.

The developed lexicon can benefit future sensory studies by providing a list of well-defined attributes relevant for oral perception of tablets. Moreover, it can be used in descriptive sensory analysis, where intensity of each attribute is scaled by a human panel. The strength of such quantitative evaluation is an ability to link its results with acceptability evaluation, i.e. define the point at which attribute intensity changes from pleasant to unpleasant. This way the characteristics of acceptable and unacceptable product can be determined.

The sensory wheel visually represents a comprehensive collection of participants' sensations triggered by tablets. The more samples tested, the more representative the wheel is for a given product; hence, the inclusion of a variety of differently coated tablets and two types of tablet cores (with and without quinine) in this study. During assessment of tasteless tablets, without the influence of a strong taste, participant perception could be focussed on descriptions of texture. In contrast, testing bitter-tasting tablets allowed a more complete

assessment akin to a real-life scenario. A wheel specific for a product category may be useful to train panellists in the variety of attributes associated with that product. It gives a clear “snapshot” of a product’s characteristics. At the same time it informs panellists of related attributes and refines the differences between them (Lawless, Hottenstein and Ellingsworth, 2011) allowing a more precise description of tested samples.

While sensory analysis is objective and does not confirm product palatability, it can identify a spectrum of attributes that dominate the sensory perception and need further evaluation for palatability. For instance, several attributes found in the sensory wheel, like *powdery*, *chemical* or *slimy*, indicate sensory issues associated with tablets with the potential to reduce palatability and subsequent acceptance.

#### **4.4 Limitations of the study**

Study limitations include the use of lay participants not trained for sensory analysis. Moreover, some participants were not native English speakers. A limited number of samples in the tablet product category was used, which could decrease the spectrum of vocabulary used.

### **5 Conclusions**

Using sensory analysis, a lexicon to describe the taste, texture and overall impression of a conventional coated tablet was generated. The data collected provides a valuable insight into the sensory experience while taking a tablet, as an exemplar oral solid dosage form. Several of the collected attributes highlighted potential sensory issues with conventional tablets that could affect the acceptability. This knowledge could be used to develop a conventional coated tablet with preferable sensory attributes. The lexicon was built to capture and define the attributes fundamental for the sensory description of tablets. A lexicon brings great value to sensory evaluation as it contains attributes that dominate the sensory perception of the product and unambiguous definitions, and thereby has the potential to inform product development. It also creates a step towards standardisation of sensory assessment and acceptability evaluation. Although a lexicon for tablets is not fully translatable to other OSDFs, these data could steer future sensory analysis of, for example, orally dispersible tablets, films, capsules, or chewable tablets. An important lesson that emerges from this work, is that pharmaceutical sensory research has distinct aims and requirements which differ from food sensory analysis. The approaches and methodologies, therefore, cannot be directly translated from food sciences but need to be adapted to achieve the different goals.

This preliminary study has generated multiple avenues for future research and development. As research in this area grows and evolves, it is expected that some attributes are removed from these tools while others are added. Further research is needed to address the issue of pharmaceutical product references to aid the practical use of lexicons and sensory wheels as standardised tools. In further work the lexicon and sensory wheel will be developed for different formulations, e.g. ODTs or liquids, and the relationships between them will be investigated with regard to palatability and acceptability.

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Table 1 List of formulations used in the study.

	<b>Formulation</b>	<b>Coating ingredients</b>	<b>Final coating level (w/w)*</b>	<b>Tablet core</b>
First set of tablets	<b>T<sub>A</sub></b>	-	0%	Oval, tasteless
	<b>T<sub>A</sub>Coat-1</b>	Opadry® 03F mix (HPMC-based)	3%	Oval, tasteless
	<b>T<sub>A</sub>Coat-2</b>	Opadry® EZ Swallow white (HPMC-based + hydrocolloid gum and MCT)	3%	Oval, tasteless
	<b>T<sub>A</sub>Coat-3</b>	Opadry® EZ Swallow white Opadry® EZ Swallow clear (HPMC-based + hydrocolloid gum and MCT)	3% + 1%	Oval, tasteless
Second set of tablets	<b>T<sub>B</sub>Coat-4</b>	HPMC 5, glycerol	4%	Round, bitter
	<b>T<sub>B</sub>Coat-5</b>	Lubritab®, Capmul® MCM, HPMC 5, talcum, titanium dioxide	4%	Round, bitter
	<b>T<sub>B</sub>Coat-6</b>	HPMC 5, xanthan gum, glycerol, talcum, titanium dioxide	4%	Round, bitter
	<b>T<sub>B</sub>Coat-7</b>	Eudragit EPO readymix, titanium dioxide	4%	Round, bitter
	<b>T<sub>B</sub>Coat-8</b>	HPMC 5, Surelease®, glycerol, talcum, titanium dioxide	4%	Round, bitter

\*as declared by manufacturer

HPMC – hydroxypropyl methyl cellulose

MCT – medium chain triglycerides

Table 2 Frequency of collected participants' comments and attributes.

	Number of cases	
	First study	Second study
All comments	883	730
Valid comments*	806	719
Varying non-repetitive attributes	128	111
Hedonic attributes	30	17
Sensory attributes	98	94
Shared sensory attributes		69
Unique sensory attributes	29	25

\*nonsensical and illegible comments excluded

Table 3 List A: Seventy-four attributes from the first tablet set ( $T_A$ ) with frequency of occurrence from the second tablet set ( $T_B$ ); shaded area - List B: forty-one most frequently used attributes (i.e. validated attributes).

<i>neutral</i>	35	<i>dusty</i>	11	<i>floury</i>	6	<i>gloopy</i>	1
<i>chalky</i>	30	<i>light</i>	11	<i>soft</i>	6	<i>minty</i>	1
<i>dry</i>	26	<i>plastic</i>	11	<i>thick</i>	6	<i>pointy</i>	1
<i>solid</i>	25	<i>doesn't fall apart</i>	10	<i>pasty</i>	5	<i>spongy</i>	1
<i>chemical</i>	24	<i>doesn't melt</i>	10	<i>artificial</i>	4	<i>aniseedy</i>	0
<i>movable</i>	20	<i>glazed</i>	10	<i>gooey</i>	4	<i>big</i>	0
<i>moves easily</i>	19	<i>silky</i>	10	<i>melts</i>	4	<i>disintegrating</i>	0
<i>rounded</i>	19	<i>alkaline</i>	9	<i>not movable</i>	4	<i>falls apart</i>	0
<i>bland</i>	18	<i>clingy</i>	9	<i>shiny</i>	4	<i>fizzy</i>	0
<i>plain</i>	18	<i>grainy</i>	9	<i>solvent taste</i>	4	<i>fluffy</i>	0
<i>small</i>	18	<i>no flavour</i>	9	<i>creamy</i>	3	<i>furry</i>	0
<i>matte</i>	17	<i>dissolving</i>	8	<i>granular</i>	3	<i>gelatinous</i>	0
<i>synthetic</i>	16	<i>gluey</i>	8	<i>gritty</i>	3	<i>glutinous</i>	0
<i>unnatural taste</i>	16	<i>no edges</i>	8	<i>not tacky</i>	3	<i>large</i>	0
<i>slick</i>	15	<i>doesn't dissolve</i>	7	<i>starchy</i>	3	<i>mushy</i>	0
<i>powdery</i>	13	<i>mobile</i>	7	<i>adherent</i>	2	<i>pliable</i>	0
<i>clean</i>	12	<i>slimy</i>	7	<i>bumpy</i>	2	<i>soggy</i>	0
<i>hard</i>	12	<i>tacky</i>	7	<i>loose</i>	2		
<i>no taste</i>	12	<i>tasteless</i>	7	<i>crumbly</i>	1		

Table 4 Tablet lexicon with sensory attribute definitions. Definitions were based on [1] ISO standard, textbooks [2] Meilgaard et al. (2006), [3] Cambridge English Dictionary (2019) or other lexicon [4] Cville et al. (2010), NA - not available.

<b>Attribute</b>	<b>Definition</b>	<b>Ref</b>
<b>Texture</b>		
Chalky	Associated with chalk, dry sensation in the mouth	[2]
Dry	Free from moisture or liquid, perception of moisture being absorbed by product	[1], [3]
Powdery	Amount of fine particles on the surface or as bulk product	[4]
Slippery	Degree to which sample slides across the tongue/palate	[2]
Adhesiveness	Degree to which the sample adheres to mouth surfaces: lips, tongue, palate, teeth (with increasing intensity level: tacky, clinging, gooey – gluey, sticky – adhesive)	[1]
Slimy	Covered in a sticky, smooth, liquid substance, as liquid covering snails	[3]
Smooth	Having regular/even surface, lack of lumps or abrasive particles	[2]
Rough	Degree of irregularity/unevenness of the product's surface; assessed by rubbing the surface	[4]
Granularity	Containing particles/granules detected by assessed by rubbing product between tongue and palate (with increasing intensity and particle size: smooth, gritty, grainy, beady, granular, coarse, lumpy)	[1]
Hard	Force required to compress/break the sample	[1]
<b>Taste</b>		
Bitter	Innately aversive basic taste sensation characteristic to caffeine	[1]
Tasteless	Having no taste, lack of chemical stimulation of taste buds	[3]
Aftertaste	Taste or odour sensation that occurs after the elimination of the product	[1]
<b>Flavour</b>		
Chemical	Flavour associated with artificial products	NA
<b>Visual perception</b>		
Size	Relative description of size (small – large)	[3]
Gloss	The tendency of a surface to reflect light (shiny – matte)	[1]
<b>Change-of-state</b>		
Dissolving	Degree to which the core of the sample dissolves in contact with saliva	NA
Disintegrating	Degree to which the core of the sample breaks up into small parts in contact with saliva	NA
Solid	Keeping a clear shape, object without any spaces or holes, integrity of shape	[2]
<b>Other</b>		
Neutral	Lack of dominant or noticeable characteristics	[1]

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Cambridge English Dictionary, 2019.

Civille, G.V., Lapsley, K., Huang, G., Yada, S., Seltsam, J., 2010. Development of an almond lexicon to assess the sensory properties of almond varieties. *Journal of Sensory Studies* 25, 146-162.

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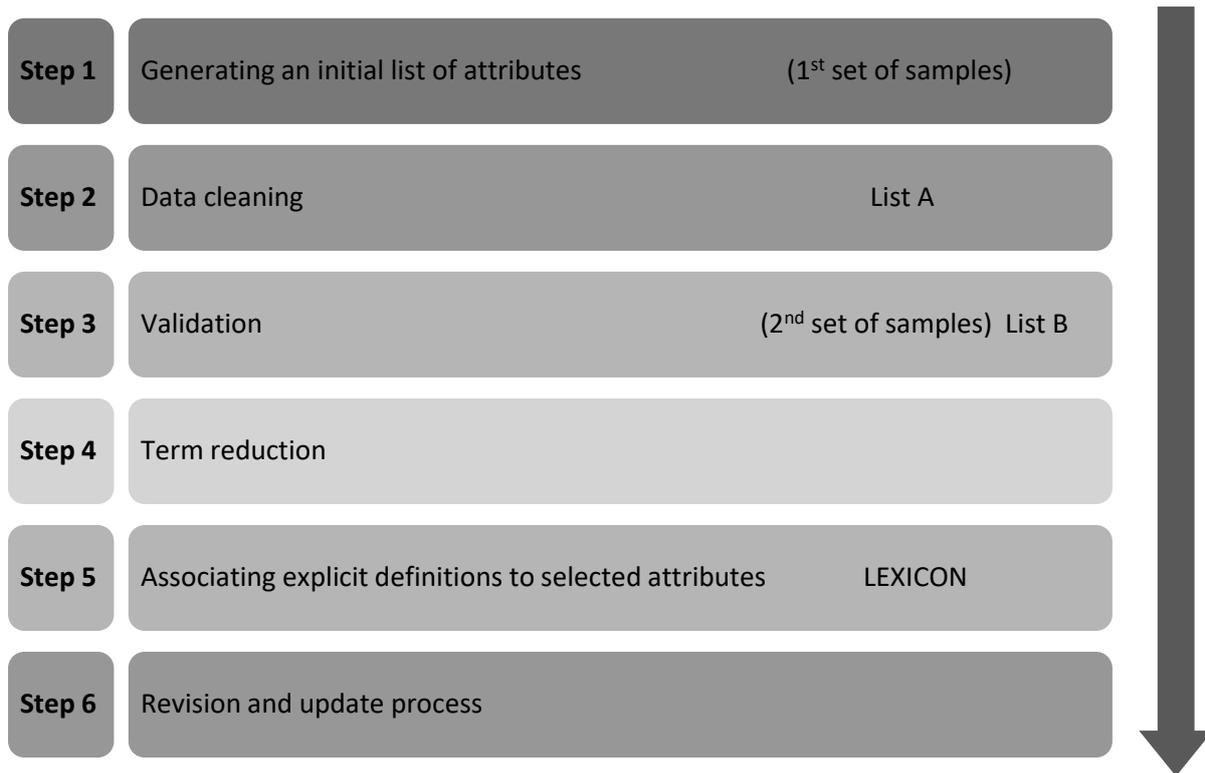


Figure 1 Process of building a lexicon for tablets; Step 6 is a prospective process (not reported in this preliminary study).

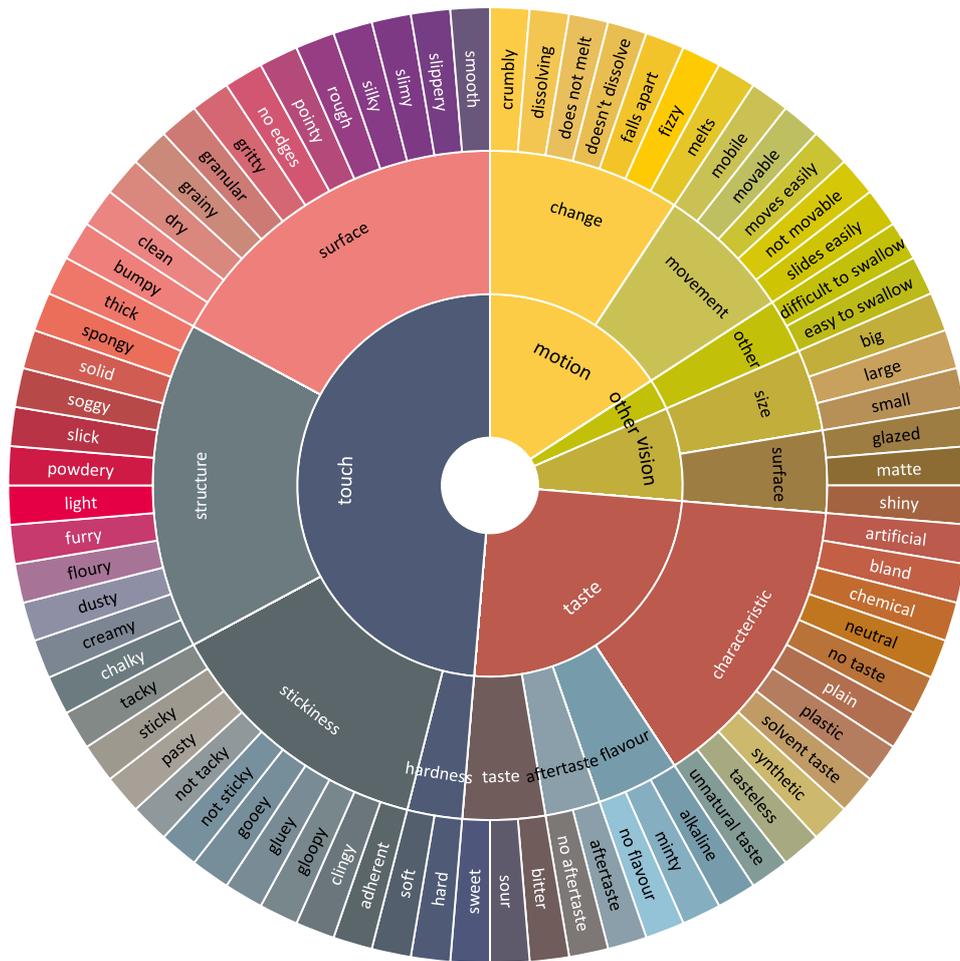


Figure 2 Tablet sensory wheel.

## Appendix A

Participant demographics.

	First sensory panel (n=83)		Second sensory panel (n=52)	
	Frequency	Percent [%]	Frequency	Percent [%]
<b>Gender</b>				
Male	34	41.0	19	36.5
Female	49	59.0	33	63.5
<b>Age (years)</b>				
<24	10	12.0	11	21.2
25-34	13	15.7	29	55.8
35-44	11	13.3	5	9.6
45-54	7	8.4	5	9.6
55-64	10	12.0	1	1.9
>65	32	38.6	1	1.9

## Appendix B

Frequency of the attributes included in the sensory wheel and their definitions. Definitions were based on [1] ISO standard (International Organization for Standardization, 2008), textbooks [2] Meilgaard et al. (2006), [3] Cambridge English Dictionary (2019) or other lexicons [4] Civile et al. (2010), [5] Kim et al. (2013) NA - not available.

Attribute	Number of participants who used the attribute (n=135)	Number of tablets described with the attribute (n=9)	Total number of uses of the attribute	Definition	Reference
adherent	3	3	3	Level of adhesiveness, i.e. degree to which the sample adheres to mouth surfaces: lips, tongue, palate, teeth (with increasing intensity level: tacky, clinging, gooey – gluey, sticky – adhesive)	[1]
aftertaste	6	5	8	Taste or odour sensation that occurs after the elimination of the product	[1]
alkaline	9	4	11	flavour produced by dilute aqueous solutions of basic substances, i.e. pH > 7,0, such as sodium hydroxide	[1]
artificial	5	4	6	Flavour associated with artificial products	NA
big	2	3	3	Relative description of size, large (opposite to small)	[3]
bitter	14	9	18	Innately aversive basic taste sensation characteristic to caffeine	[1]
bland	17	8	24	With a low level of flavour	[1]
bumpy	5	3	5	Having not smooth, uneven surface	[3], [4]
chalky	40	9	53	Associated with chalk, dry sensation in the mouth	[2]
chemical	21	7	27	Flavour associated with artificial products	NA
clean	13	7	17	property of leaving no lingering mouth after-feel once swallowed	[1]
clingy	8	6	10	Level of adhesiveness, i.e. degree to which the sample adheres to mouth surfaces: lips, tongue, palate, teeth (with increasing intensity level: tacky, clinging, gooey – gluey, sticky – adhesive)	[1]
creamy	4	4	4	Level of viscosity, i.e. degree of resistance to flow (with increasing intensity: fluid, thin, creamy, thick)	[1]
crumbly	5	2	5	Level of fracturability, i.e. degree to which the sample breaks into pieces under force (with increasing intensity level: cohesive, crumbly, crunchy, brittle, crispy, crusty, pulverulent)	[1]
difficult to swallow	2	1	2	Amount of effort required to swallow a sample	[5]
dissolving	30	5	37	Degree to which the core of the sample dissolves in contact with saliva	NA
does not melt	12	6	12	Opposite to melting	NA

doesn't dissolve	15	8	21	Opposite to dissolving	NA
dry	25	8	35	Free from moisture or liquid, perception of moisture being absorbed by product	[1], [3]
dusty	10	6	13	Covered in dust, associated with dirt, soil	[3]
easy to swallow	10	4	13	Amount of effort required to swallow a sample	[5]
falls apart	3	1	3	Prone to fracturability, i.e. breaking into pieces	NA
fizzy	3	1	3	Having bursting bubbles, effervescent	[1]
floury	9	4	9	Covered in flour, having a taste or feel like flour	[3]
furry	2	1	2	Covered in fur, made from soft material like fur	[3]
glazed	8	5	11	Covered with a smooth, shiny coating	[3]
gooepy	2	2	2	Level of adhesiveness - thick or sticky	[3]
gluey	10	6	12	Level of adhesiveness, i.e. degree to which the sample adheres to mouth surfaces: lips, tongue, palate, teeth (with increasing intensity level: tacky, clinging, gooey – gluey, sticky – adhesive)	[1]
gooey	5	4	5	Level of adhesiveness, i.e. degree to which the sample adheres to mouth surfaces: lips, tongue, palate, teeth (with increasing intensity level: tacky, clinging, gooey – gluey, sticky – adhesive)	[1]
grainy	10	7	13	Level of granularity, i.e. containing particles/granules detected by assessed by rubbing product between tongue and palate (with increasing intensity and particle size: smooth, gritty, grainy, beady, granular, coarse, lumpy)	[1]
granular	4	4	4	Level of granularity, i.e. containing particles/granules detected by assessed by rubbing product between tongue and palate (with increasing intensity and particle size: smooth, gritty, grainy, beady, granular, coarse, lumpy)	[1]
gritty	6	5	6	Level of granularity, i.e. containing particles/granules detected by assessed by rubbing product between tongue and palate (with increasing intensity and particle size: smooth, gritty, grainy, beady, granular, coarse, lumpy)	[1]
hard	20	7	24	Level of hardness, i.e. force required to compress/break the sample (with increasing intensity: soft, firm, hard)	[1]
large	8	4	11	Relative description of size (opposite to small)	[3]
light	9	5	12	Low level of density	[1]
matte	16	6	18	Lack of the tendency of a surface to reflect light (opposite to shiny)	[1]
melts	9	5	10	Level of chewiness, i.e. work required to masticate solid product (with increasing intensity: melting, tender chewy, tough)	[1]
minty	3	2	3	With a characteristic taste or smell of mint (herb with strong, fresh flavour)	[3]
mobile	7	7	10	Moving freely	[3]
movable	13	5	22	Able to be moved	[3]
moves easily	26	8	36	Amount of effort required to move a sample	NA

neutral	41	9	62	Lack of dominant or noticeable characteristics	[1]
no aftertaste	5	5	5	Lack of taste or odour sensation that occurs after the elimination of the product	[1]
no edges	7	6	9	Lack of or difficult to perceive edges	NA
no flavour	8	5	10	Lack of flavour, i.e. chemical and trigeminal stimulation	[1]
no taste	20	6	27	Lack of chemical stimulation of taste buds	[3]
not movable	6	6	10	Opposite to movable	NA
not sticky	4	2	5	Lack of stickiness	NA
not tacky	4	3	4	Lack of tackiness	NA
pasty	6	5	7	Level of gumminess, i.e. degree of effort required to disintegrate the product (with increasing intensity: short, mealy, pasty, gummy)	[1]
plain	16	7	20	Simple, with nothing added	[3]
plastic	9	8	15	With characteristic of or associated with plastic – artificial pliable material	[3], [4]
pointy	2	2	2	Shaped into a point	[3]
powdery	36	9	41	Amount of fine particles on the surface or as bulk product	[4]
rough	36	6	44	Degree of irregularity/unevenness of the product's surface; assessed by rubbing the surface	[4]
shiny	5	4	6	The tendency of a surface to reflect light (opposite to matte)	[1]
silky	13	5	15	Soft and smooth	[3]
slick	12	4	16	Having a smooth, shiny surface	[3]
slides easily	3	2	3	Amount of effort required to move over the surface	[3]
slimy	16	8	20	Covered in a sticky, smooth, liquid substance, as liquid covering snails	[3]
slippery	43	6	63	Degree to which sample slides across the tongue/palate	[2]
small	12	6	19	Relative description of size (opposite to large)	[3]
smooth	65	7	117	Having regular/even surface, lack of lumps or abrasive particles	[2]
soft	11	5	11	Level of hardness, i.e. force required to compress/break the sample (with increasing intensity: soft, firm, hard)	[1]
soggy	2	1	2	Lack of crispiness, i.e. no force is needed to break or fracture a product; wet and soft	[2], [3]
solid	27	8	35	Keeping a clear shape, object without any spaces or holes, integrity of shape	[2]
solvent taste	5	3	5	Flavour associated with a solvent or flavour carrier; reminiscent of ethanol or vodka	[4]
sour	4	4	4	Basic taste sensation, generally due to presence of organic acids	[1]
spongy	2	2	2	Soft and able to absorb or having already absorbed a lot of liquid	[3]

sticky	46	9	53	Level of adhesiveness, i.e. degree to which the sample adheres to mouth surfaces: lips, tongue, palate, teeth (with increasing intensity level: tacky, clinging, gooey – gluey, sticky – adhesive)	[1]
sweet	17	5	17	Basic taste sensation, characteristic to sucrose or aspartame	[1]
synthetic	12	6	17	Flavour associated with artificial products	NA
tacky	10	6	13	Level of adhesiveness, i.e. degree to which the sample adheres to mouth surfaces: lips, tongue, palate, teeth (with increasing intensity level: tacky, clinging, gooey – gluey, sticky – adhesive)	[1]
tasteless	26	7	33	Having no taste, lack of chemical stimulation of taste buds	[3]
thick	7	4	7	Level of viscosity, i.e. degree of resistance to flow (with increasing intensity: fluid, thin, creamy, thick)	[1]
unnatural taste	12	5	16	Flavour associated with artificial products	NA

## References

Cambridge English Dictionary, 2019.

Civille, G.V., Lapsley, K., Huang, G., Yada, S., Seltsam, J., 2010. Development of an almond lexicon to assess the sensory properties of almond varieties. *Journal of Sensory Studies* 25, 146-162.

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## Appendix C

Transcription of participants' comments. Each line represents description of a single participant.

**T<sub>A</sub>**

---

*rough texture, slightly minty taste*

---

*sticky, rough*

---

*immediately started dissolving and sticky to the tongue*

---

*dissolves, pleasant, rough*

---

*nasty, chalky, rough*

---

*tasty, starting to dissolve*

---

*powdery, chalky texture*

---

*soggy, chalky, slimy*

---

*rough, sticky, tastes a little*

---

*unpleasant, chalky, dry*

---

*disgusting taste, coating melted so quickly (fastly), stays in place*

---

*fizzy, like baking powder, soft*

---

*stronger flavour, crumbly, powdery*

---

*rough, sticky, sweet*

---

*powdery, rough, dissolving*

---

*chalky, clingy*

---

*powderish, melting in the mouth*

---

*powdery, aftertaste*

---

*melted in the mouth, was not as expected, felt like there was no coating on the tablet*

---

*dry, a bit powdery at the end of the time/slimy, a bit fizzy at the end of the time*

---

*powdery, sticky*

---

*sticky, rough, weight loss*

---

*soft, chalky, difficult to move around*

---

*tasteless*

---

*evaporated on tongue, rough, powdery*

---

*rough, sticky*

---

*powdery, dry*

---

*the test not good, stay in place, become pices/powder*

---

*rough, dry, unpleasant*

---

*chalky, powdery, dissolves*

---

*dry, tacky, dissolving*

---

*dissolvable, not nice but not bad*

---

*chalky, melts*

---

*leaves a taste in the mouth, very rough on the palate, not pleasant*

---

*tacky, powdery, rough*

---

*rough, not easy to chew or swallow, sticky*

---

*dissolves quickly in mouth, sweet, strange, large*

---

*dissolves quickly, feels rough initially, difficult to swallow, 2 attempts with water*

---

*milky, fluffy, granular*

---

*powdery, tasted neutral, adherent*

---

*sticky, unpleasant texture*

---

---

*coating dissolves, sticky, stimulated saliva*

---

*initially dry, sweetish after a while, slightly powdery*

---

*felt as it would totally dissolve in the mouth, very unpleasant, quite large*

---

*powdery, dissolving slowly, comfortable*

---

*rough, alkaline, powdery*

---

*felt as though it was dissolving slowly, acceptable, gentle*

---

*fizzy, breaks apart, odd*

---

*terrible*

---

*mushy, sticky, ugh*

---

*chalky, dissolves quickly, unpleasant taste, very hard to move in mouth, horrible*

---

*very chalky, dissolves quickly, no aftertaste*

---

*rougher surface, sticks to the tongue, taste less pleasant*

---

*very chalky, alkaline taste, very strange unpleasant texture, melted in mouth but powdery also, very sticky*

---

*tablet felt softer as it was going to dissolve, tablet dissolved much more quickly than previous two, tablet was softer feel in mouth*

---

*tacky, disintegrated, yuk*

---

*dusty, crumbly, bitter*

---

*sticky, sweetish, dissolving*

---

*powdery, dissolves in mouth, sticky to swallow*

---

*nasty, glutenous, powdery*

---

*chalky, powdery*

---

*floury, sticky, resistant*

---

*chalky, rough, unpleasant*

---

*rough, falls apart easily, slightly sweet*

---

*rough, sticky, starts to dissolve*

---

*big, very sticky/powdery, bad/strong taste, but not bitter*

---

*dissolves, chalky, sticky*

---

*sticky, furry, uncomfortable*

---

*chalky, powdery, sticky*

---

*tacky, insolvent, quite a pleasant taste*

---

*large, dissolving, rough*

---

*loose, rough, uncomfortable*

---

*bad texture, slightly minty, soggy*

---

*dusty, slightly sticky, not too large*

---

*rough, pleasant taste*

---

*furry, gelatinous, large*

---

*comfortable, rough (ish), crumbly*

---

*I didn't like this one, horrible, rough, felt like it was dissolving*

---

*floury, sweet, unpleasant*

---

*spongy, soft, Pliable*

---

*crumbles, powdery, unpleasant*

---

*unpleasant, sweet, tastes like flour*

---

## **T<sub>A</sub>Coat-1**

*smooth*

*started to feel rough after 15s and could taste*

*solvent like taste which developed after few seconds, then powdery gritty texture after 20s*

*sticky*

*mealy, smooth, big*

*neutral*

*smooth, slightly sticky, nice*

*smooth, moves easily, slight taste*

*smooth, pleasant, easy*

*stick in the mouth, doesn't move easily, taste is not good*

*tasteless, sticky, hard, didn't begin to fall apart*

*chemical, lingering, hard*

*smooth, easy, neutral*

*shiny, plain, slippery*

*unpleasant taste, texture and aftertaste*

*feels more sticky than others*

*the coating seemed somewhat plastic feeling in the mouth, started to feel like melting in second 9*

*smooth*

*weird taste*

*slippery, no weight loss, smooth*

*smooth, than slight granulation, should swallow easily*

*swallowable, tastes bad*

*glue textured, stodgy*

*acceptable, smooth*

*smooth, comfortable*

*bad test, hard, no easy, slips*

*smooth, pleasant, slippery*

*smooth, slippery, chemically*

*powdery, pleasant, dry*

*sticky, dissolves a bit, broke in half and disolves*

*gooey, aftertaste, smelly*

*very similar to 630, smooth texture, easy to move around*

*sticky, tacky*

*slippery, no taste, easy suck*

*neutral taste, slips but starts to dissolve slowly in the mouth, still possible to swallow*

*sweet, becomes more difficult to swallow as coating dissolves, didn't seem to swallow completely, 2 attempts with water*

*slipps, pleasant, solid*

*distasteful - tasted plasticky, smooth at first but it very quickly becomes unpleasant, almost starchy, starchy*

*an object in the mouth, smooth, slippery*

*no taste, didn't dissolve*

*smooth, quite large, not unpleasant to taste*

*ok, silky, bland*

---

*sticky, untasty, silky*

---

*tasteless until slight hint of mint when spat out, didn't feel it would ever dissolve, would be easy to swallow*

---

*grainy, bitter, sticky*

---

*slimy, bitter, smooth*

---

*starts smooth but becomes sticky, chalky after 7-8s, taste not bad until 8+ seconds when it becomes more pronounced*

---

*leaves an aftertaste, not pleasant, slimy texture*

---

*initially smooth then rougher, moves around easily, not as palatable as 531*

---

*very unpalatable taste, artificial, very smooth until first layer dissolves, was also very sticky, left a chalky residue on the tongue which was also unpleasant*

---

*best to take out of 4, slightly rough, strange taste*

---

*smooth, sticky, unpleasant*

---

*smooth, cardboardy, pleasant*

---

*neutral, easy, solid*

---

*pleasant, large, stickier*

---

*smooth, clean*

---

*slippy then chalky, unpleasant*

---

*tacky, resistant, neutral taste*

---

*smooth, neutral taste, easy*

---

*a little slippery/slimy, sticky, smooth*

---

*smooth, tasteless, neutral*

---

*light powder, tastes odd but not bad, rounded*

---

*soft, sticky yet not sticky, chalky*

---

*comfortable, mild taste, smooth*

---

*smooth, slippy, tasteless*

---

*non descript, just a tablet!, moves around palate, not unpleasant, no taste at all*

---

*unpleasant, synthetic*

---

*smooth, easy, bland*

---

*easy, no taste, smooth*

---

*slightly grainy, not too large, manageable*

---

*feels a bit rougher the longer it stays on tongue*

---

*sweeter than others, comfortable, more unnoticeable*

---

*smooth, neutral, pleasant*

---

*smooth, silky, no aftertaste*

---

*smooth, towards end of 10 seconds felt it might dissolve, a little sticky*

---

*glue like, unpleasantly sticky, obtrusive*

---

*solid, smooth, resistant*

---

*milky, bitter, sticky*

---

## **T<sub>A</sub>Coat-2**

---

*slight chemical taste*

---

*smooth, slippery, palatable*

---

*poor, sticky*

---

*bland, big*

---

*slightly sour*

*smooth, slippery, pleasant*

*smooth, moves easily if I tried, no flavour*

*average*

*doesn't taste, slip easily, smooth*

*almost sweet taste, smooth*

*aniseedy, solid (didn't crumble), pleasant*

*smooth, easy, clean*

*slippery, rough, uninvasive*

*sweeter*

*neutral, slippery*

*no taste, feels like some of coating left on roof of mouth*

*slippery, felt coating was stronger, did not melt in the mouth*

*a little dry, a little bumpy*

*slippery, no weight loss, smooth*

*comfortable, sticks, probably ok*

*smooth, unnatural taste, slippery*

*pleasant, slides easily, quite acceptable*

*comfortable, smooth*

*easy to slips, good test, hard*

*pleasant, creamy, smooth*

*smooth, neutral, slippery*

*smooth, acceptable, tasteless*

*large,unweidly, rough the longer in the mouth*

*aftertaste*

*smooth mostly, easy to move around, tasteless*

*moveable, nothing descriptive to say*

*smooth, easy to swallow, no taste*

*neutral, no taste, slippery, smooth, easy to swallow with water*

*smooth, doesn't dissolve, swallows easily*

*slimy, unplesant*

*smooth, passes easily in the mouth, textureless*

*fine, smooth*

*an object in the mouth, moves easily against the palate, does not stick*

*no taste, didn't dissolve in mouth*

*a bit gritty, neither pleasant or unpleasant, not too smooth*

*slightly sweet, smooth, slippery*

*sticky, slimy, slightly bitter*

*tasteless, hard, didn't think it would ever dissolve if I couldn't swallow it*

*slightly grany but not distracting, chemically taste, movebale*

*rough, chalky, sweet*

*fairly smooth with slight bumpy texture but pleasant enough, slips around fairly easily in mouth, taste not offensive, after 8s becomes very slightly chalky*

*thick, not unpleasant, swallowable*

*neutral taste, very slippery, felt it would be easy tgo swallow*

*very smooth and slippy, not sticky at all, not nice taste, artificial and bitter*  
*tablet not too rough, table did not stick at all, slightly rough*  
*slippery, tasteless, ok*  
*dry feeling, easy to move around, no taste*  
*preferred, easy, tasteless*  
*menagable, slightly rough, neutral flavour*  
*solid, smooth, clean*  
*hard, bland*  
*surface matt, mobile, tasteless*  
*slightly rough, bit of taste, neutral*  
*smooth, slightly chalky, slightly salty, not unpleasant*  
*slightly rough, ok, slightly sweet*  
*smooth, small, good, not unpleasant*  
*rough, not dissolve*  
*comfortable, tasteless, free-moving*  
*smooth, slippy, tasteless*  
*not tacky, slippy, not unpleasant, had no taste what so ever (or I have lost my sense of taste!)*  
*smooth, plastic*  
*smooth, comfortable, tasteless*  
*antiseptic taste, unpleasant*  
*solid, neutral, slightly large*  
*neutral taste*  
*very easily moves*  
*comfortable, neutral, not unpleasant*  
*rough on the tongue, slght aftertaste, moved around mouth easily*  
*smooth, slippy, easy to move*  
*slippery, uncomfortable, slimy*  
*powdery outer coating, hard, slimy*  
*rough, tasteless, more on a pleasant side*

### **T<sub>A</sub>Coat-3**

*normal*  
*smooth, slippy, pleasant*  
*pasty*  
*silky smooth, slippery, pleasant feel*  
*slippery, tasteless, imagine easy to swallow*  
*smooth, pleasant, easy*  
*coating does not melt easily, taste is acceptable, slips easily and quite smooth*  
*smooth, almost grainy, with time, with time+mix with saliva, tasteless*  
*paste like taste, smooth, easy*  
*smooth, slippery, neutral*  
*smooth, slippery, uninvasive*  
*holds together*  
*quite unusually sweet taste for a tablet*

*felt a slimy in mouth towards end*

*smoothish*

*smooth*

*smooth, slippery, no weight loss*

*slipps easily, not uncomfortable, taste improvement*

*slippery, smooth, taste bit unpleasant*

*tasteless, slippery*

*smooth, didn't cause me any problems*

*smooth*

*hard, stay in place, pleasant*

*smooth, pleasant, slippy*

*smooth, slippery, neutral*

*accetable, fairly smooth, ok*

*large, solid, no too bad*

*easy, ok, large*

*very smooth, slides easily, no aftertaste*

*slippy, smooth, shiny*

*slippery, no taste, easy to swallow*

*neutral taste, no taste, easy to swallow, doesn't dissolve, slippery*

*smooth, doesn't dissolve, swallows easily*

*coating sticks to the tongue, unpleasant, slimy*

*smooth, tablet became less smooth after approximately 20s, easy to take, fine*

*smooth, nice, I wish all tablets are like this product*

*slippery, smooth, not sticky*

*no taste, didn't dissolve*

*no taste at all, very slippy, no at all sticky*

*smooth, fairly slippery, bland taste*

*smooth, hard, tasteless*

*hard, tasteless, not sure if would have dissolve if I couldn't swallow it*

*neutral, slippery, plain*

*smooth, slightly bumpy, slippery*

*comfortable*

*slightly rough, a bit gloopy, slightly gritty texture*

*glue like, slimy, not pleasant*

*tasteless, comfortable balance between smooth+stickiness*

*smooth, strange taste, chalky*

*smoother than previous, not much different than 299, like previous*

*smooth, ok, slight taste*

*smooth, not too big, easy to suck*

*neutral, slippery, hard*

*smooth, slippery, pleasant neutral taste*

*clean, solid, pleasant*

*bland, smooth*

*smooth, mobile, tasteless*

---

*slightly rough, easy swallowable, tasteless*

---

*super smooth, very slippery, slightly salty/not unpleasant*

---

*smooth, slippery, neutral*

---

*slightly bitter, bad taste, slippery, average size feeling in the mouth*

---

*hard, sweet*

---

*smooth, tasteless, free-moving*

---

*super smooth, slick, nice*

---

*slippy, slides around, slight taste but not unpleasant*

---

*smooth, plastic*

---

*sticky, smooth, comfortable*

---

*odd taste after a few seconds, quite rough for a tablet*

---

*solid, mobile, not intrusive*

---

*slippery, pleasant taste*

---

*powdery, large, indigestible*

---

*neutral, not unpleasant, ok*

---

*weird aftertaste, only very slight though, silky, smooth*

---

*tasteless, didn't start to dissolve until right at end of time, smooth*

---

*light, feels glazed, pointy*

---

*slimy outer surface, solid, dry aftertaste*

---

*a bit bitter, slips easily, didn't feel edges of this tablet*

---

#### **T<sub>B</sub>Coat-4**

---

*moves easily, shiny, clean*

---

*movable, glazed, light*

---

*unambiguous, slimy, silky*

---

*neutral, okay, strong taste, slick, moves easily*

---

*not tacky, silky, melts, the coating totally dissolved by the end of 5s*

---

*bitter, quite sticky*

---

*dry, absorbant, sour*

---

*nice textural, in the beginning not bitter*

---

*rounded, hard, dense*

---

*slick, clean, rounded*

---

*round, unnatural taste, hard*

---

*chemical, grainy, solvent taste*

---

*dissolving, unnatural taste, granular*

---

*neutral, solid, small*

---

*edgy, smushy, flat*

---

*does not melt, chalky, chemical*

---

*chemical, alkaline, gooey*

---

*shiny, slick, no flavour*

---

*solvent taste, synthetic, starchy*

---

*bland, gluey, moves easily*

---

*slimy, glazed, no edges*

---

*chalky, powdery, dissolving*

---

*synthetic, no edges, matte,*  
*movable, unnatural, light*  
*chemically, doesn't fall apart, not tacky*  
*dry, clingy, hard*  
*synthetic, gooey, pasty*  
*chalky, small, 'like paracetamol'*  
*unnatural taste, chalky, dissolving*  
*chemical, slimy, plastic*  
*plain, smooth, hard*  
*dissolving, bland, pasty*  
*alkaline, movable, rounded*  
*chalky, solid, dry*  
*doesn't dissolve, small, rounded*  
*moves easily, no edges, slick*  
*rounded, movable, mobile*  
*plastic, synthetic, rounded*  
*chemical, matte, tacky*  
*silky, pleasant, clean*  
*gooey, thick, does not melt*  
*matte, rounded, does not melt*  
*tasteless, neutral, light*  
*adherent, alkaline, gluey*  
*dusty, chalky, unnatural taste*  
*aftertaste better*  
*alkaline*  
*smooth, chalky, silky*  
*matte, smooth, strange taste, glazed*

#### **T<sub>B</sub>Coat-5**

*moves easily, bland, gelly like, average small sized tablet*  
*moves easily, neutral, glazed*  
*obtrusive, nasty, smooth*  
*nice, smooth, surprising bad aftertaste, small slick, doesn't fall apart*  
*clean, plain, bland, dissolution of the tablet left greasy feeling on the tongue*  
*neutral feelings!*  
*pleasant, moveable*  
*little bitter, neutral*  
*bland, chalky, light*  
*bland, neutral, solid*  
*light, neutral, doesn't dissolve*  
*silky, plain, doesn't fall apart*  
*movable, no taste, solid*  
*small, neutral, mobile*  
*small, no taste, soft to touch*

*moveable, no edges, no flavour*

*neutral, rounded, plain*

*glazed, silky, no flavour*

*movable, neutral, solid*

*mover easily, slick, glazed*

*chalky, powdery, dry*

*plain, simple, small*

*movable, neutral, starchy*

*light, pleasant, movable*

*small, tasteless, clingy*

*no flavour, doesn't dissolve, soft*

*solid, clean, bland*

*neutral, solid, small*

*solid, matte, tasteless*

*powdery, plastic, chemical*

*bland, neutral, no taste*

*it seems neutral, with no flavour, with no taste*

*does not melt, moves easily, small*

*bland, movable, no taste*

*solid, doesn't fall apart, hard*

*rounded, neutral, movable*

*synthetic, plastic, solid*

*neutral, plain, light*

*gritty, unpleasant, clingy*

*clean, plain, solid*

*sweet, dusty, powdery*

*no taste, no flavour, clean*

*neutral, silky, matte*

*not a problem*

*bland, fake, plastic, didn't enjoy this tablet*

*no taste, does not melt, small*

*feels easy to swallow*

*no taste, pasty*

*smooth, clean, bland*

*slippery, extremely small aftertaste, slight stick, generally plain*

### **T<sub>B</sub>Coat-6**

*silky, movable, neutral*

*glazed, movable, solid*

*overt, tough, bad*

*dry, smooth, neutral, bit taste, gooey, slick*

*synthetic, creamy, tacky, after the dissolution of the coating ( at the end of 10 secs) the stickiness of the core was left*

*started to like it at some point!*

*smooth*

*pleasant, nice, minimal bitter*

*easy*

*clean, soft, lubricated*

*no taste, slick, doesn't dissolve*

*neutral, small, rounded*

*dissolving, dusty, floury*

*unnatural taste, medicine-like*

*mobile, silky, chemical*

*bitter, dry, synthetic*

*moves easily, neutral, does not fall apart*

*moves easily, solid, rounded*

*slick, slimy, moves easily*

*movable, soft, clean*

*clingy, not movable, gluey*

*slimy, silky, smooth*

*soft, neutral, movable*

*slick, chemical, unnatural taste*

*light, moves easily, tasteless*

*plastic, slick, small*

*shiny, rounded, slick*

*chalky, matte*

*moves easily, slick, coated*

*starchy, pasty, moves easily*

*moves easily, doesn't fall apart, chemical*

*smooth, moves easily, quinine tasting*

*bland, chemical, synthetic*

*light, small, solid*

*artificial, rounded, moves easily*

*neutral, bland, tasteless*

*no taste, no edges, neutral*

*movable, mobile, shiny*

*plastic, synthetic, rounded*

*greasy, melts, slick*

*sticky, grainy, solid*

*gluey, melts, clingy*

*synthetic, unnatural taste, dry*

*no taste, no flavour, neutral*

*glazed, doesn't fall apart, plastic*

*not as bad as the others*

*clean, smooth, tasteless*

*strong bitter aftertaste*

*minimal taste*

*powdery, plain, sour*

*tasteless, slick, not much flavour, generally slippery, no strong bitter aftertaste*

## **T<sub>B</sub>Coat-7**

*plain, not movable, matte*

*dry, chalky, light*

*unpleasant, unassuming, chalky*

*unsmooth, bitter, slow, chalky, doesn't move easily, hard*

*synthetic, tacky, grainy*

*a bit sour maybe as well?*

*dry*

*dry, bad surface*

*stick, glued down*

*chalky, powdery*

*papery, dry, unnatural taste*

*neutral, solid, bland*

*chalky, bumpy, alkaline*

*dusty, chalky, bitter, artificial medicine-like taste*

*little tangy, hard*

*very firm, gluey, has sharp edges (pointy)*

*floury, loose, alkaline*

*chalky, doesn't dissolve, dusty*

*solid, light, doesn't dissolve*

*clingy, plain, neutral*

*does not melt, artificial, moves easily*

*dusty, hard, chalky*

*matte, dry, plastic*

*chalky, no edges, thick*

*easy, no flavour, mobile*

*chalky, matte, gluey*

*plain, dry, tacky*

*bland, neutral, plain*

*rough, neutral, dusty*

*pasty, floury, matte*

*powdery, no taste, not tacky*

*gooey, slimy, grainy round edges*

*a bit chalky, dry, plain*

*dry, matte, solid*

*granular, creamy, chalky*

*gritty, a little dry, small*

*matte, grainy, bumpy*

*solid, doesn't dissolve, chalky*

*matte, hard, solvent taste*

*spongy, unnatural taste, chemical*

*powdery, sticky, clingy*

*dry, neutral, plain*

*powdery, solvent taste, floury*

*slightly bitter, clingy, does not melt*

*chalky, floury, powdery*  
*horrible*  
*matte, dry, gritty*  
*aftertaste not bad*  
*taste like a cleaning product, alkaline, unnatural, chemical*  
*plain, neutral, solid*  
*immediate unnatural taste, slightly sticky, bit unpleasant*

### **T<sub>B</sub>Coat-8**

*not movable, plain, neutral*  
*glazed, movable, solid*  
*abusive, sticky, permcting*  
*nice, smooth, good, rough, mobile, doesn't fall apart*  
*little bit grainy, chalky, dry*  
*bitter, but not terribly*  
*semi-dry, slightly sticky*  
*bad aftertaste, good surface*  
*neutral, not much aftertaste*  
*tacky, crumbly, absorbent*  
*unnatural taste, chemical, bland*  
*doesn't melt, clean, neutral*  
*rounded, chemical, alkaline*  
*powdery, unnatural taste, chemical*  
*neutral, dry, tangy*  
*chemical taste, smooth, slippery*  
*gluey, slimy, melts*  
*chalky, tacky, does not melt*  
*alkaline, unnatural taste, doesn't melt*  
*solid, no edges, movable*  
*bad taste, grainy, unpleasant*  
*dusty, strong flavour, dry*  
*dry, unnatural taste, dissolving*  
*synthetic, hard, glazed*  
*unnatural, thick, movable*  
*chemically, small, doesn't fall apart*  
*minty, dry, small*  
*adherent, thick, chemical*  
*matte, chalky, dusty*  
*grainy, chalky, powdery*  
*dissolving, chemical, plastic*  
*hard, mobile, chemical*  
*dissolving, granular, thick*  
*moves easily, no edges, soft*  
*solid, synthetic, bland*

*hard, solid, slightly drying*

---

*rounded, loose, creamy*

---

*doesn't fall apart, chalky, solid*

---

*plastic, synthetic, rounded*

---

*synthetic, unnatural taste, tacky*

---

*clingy, rough, grainy*

---

*matte, chemical, gluey*

---

*chalky, powdery, dusty*

---

*slightly bitter, plain, clean*

---

*dusty, chemical, synthetic*

---

*dry, thick, artificial, tastes like paracetamol*

---

*bitter aftertaste*

---

*bland, unnatural*

---

*unnatural taste, floury, sharp*

---

*sticky, slightly bitter, slightly chemical*

---