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Fluoride Content, Cost and Labelling of Commercially Available Toothpastes in Malaysia

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ABSTRACT

The objectives of this study were to document the ingredients of toothpastes that are available in Malaysia and to explore the cost, manufacturers' recommendations for toothpaste use and their labelling practices. Commercially available toothpastes were identified from online and offline (over-the-counter) markets. An online search was conducted through major online shopping websites in Malaysia. For the offline market, selected major pharmacies, supermarkets, family marts and traditional medicine stores in the Klang Valley area were visited. Relevant information (i.e. the type of fluoride, fluoride concentration, type of abrasive agent, price per item and recommendation for use) on the toothpaste packaging were recorded. Data were analysed descriptively using Microsoft Excel and SPSS. A total of 176 brands of toothpaste were identified in this survey. About 74.57% and 25.43% were indicated for adults and children use respectively. Among these, 47.98% were labelled as fluoridated toothpaste and 50.29% were labelled as non-fluoridated toothpaste. Different units of labelling were used to indicate the presence of fluoride and its concentration. Generally, common abrasive agents used were silica, phosphates and carbonates. The cost of toothpaste per 10g ranged from RM0.10 to RM9.50, with mean of RM1.90 (SD 1.93). Manufacturers' recommendation of toothpaste use varied with a small proportion following evidence-based recommendations. In conclusion, there were a large variety of toothpastes available in Malaysia. The cost of toothpaste varied greatly across brands. There was a lack of standardisation regarding labelling practices and recommendations of use by the manufactures, which may place the consumers and dental health professionals at a disadvantage.

Keywords: *Cost; fluoride; labelling practice; toothpaste; Malaysia.*

INTRODUCTION

The prevalence of dental caries has shown a decreasing trend worldwide (Frencken *et al.*, 2017). Several factors contributed to caries reduction. One of the most significant factor contributing to this trend is the use of fluoride (Petersen and Ogawa, 2016). It has been well documented in the literature that fluoride can enhance remineralisation and retard the demineralisation process, hence preventing caries progression

(O'Mullane *et al.*, 2016; Petersen and Ogawa, 2016). The main mode of fluoride delivery is topical which is frequently used in toothpaste (Canadian Paediatric Society, 2002; O'Mullane *et al.*, 2016). To ensure effective fluoride delivery using toothpaste, appropriate labelling is important to aid consumers in making the correct choices.

Although there is strong evidence on effectiveness of fluoride in caries prevention, there is still on-going controversy over fluoride use, either in drinking water or toothpaste. Resistance has been growing worldwide against fluoride, emphasising on the possible risk of toxicity (Aoun *et al.*, 2018). Thus, information regarding the number of non-fluoride toothpastes in the market is important for practicing dental professionals to advise their patients appropriately.

Due to globalisation and advancement in technology, there has been an influx of toothpaste availability in Malaysia, either through online or over-the-counter products. Thus, purchasing the correct toothpaste may be confusing to the consumers. In developed countries such as the United States, the standard of labelling practices is strictly monitored under The Regulation of Toothpaste by Food and Drug Administration (FDA). It was also highlighted that the products may not be marketed if the labelling is misleading or the advertisement contains false claims (Sandier, 1997). In Malaysia, a guide on the use of fluoride, published by the Malaysian Dental Council, states that the fluoride concentration in toothpaste for the use of children under six years old should be displayed with a specific indication on the packaging and container (Malaysian Dental Council, 2009). However, a recent local study by Gundavarappa *et al.* (2017) reported poor labelling practice of toothpaste marketed in Malaysia. The problem persists, although this issue was highlighted 20 years ago by Musa and Saub (1998). This is worrying as consumers rely on the labelling to get key information about the product before purchasing.

In addition, there are several factors associated with the choice of toothpaste among consumers. These factors include the ingredient, brand, perceived performance and manufacturers' recommendation of the product (Opeodu and Gbadebo, 2017). For example, in terms of the ingredient, some consumers may have concerns about the fluoride content, while others are concerned about the herbal content. Although the importance of fluoride toothpaste has been well documented, a study has reported that fluoride-containing toothpaste may not be globally affordable (Goldman *et al.*, 2008). The cost of the product may be one of the major factors that may influence consumer's choice of toothpaste. Whether the cost of fluoridated and non-fluoridated toothpaste differ significantly in Malaysia remains unexplored.

The previous two local studies (Musa and Saub, 1998; Gundavarappa *et al.*, 2017) only included a small samples size and mainly focused on the type of fluoride content in the toothpaste. Details of other information on the packaging were not reported. Therefore, it is essential to know what is available in the current market in Malaysia. The findings will be beneficial for the consumers to assist them in choosing an appropriate toothpaste. Also, the data will serve as a guide for dental health professionals to provide specific advice on toothpaste for their patients. The findings will also be useful to validate research data on the self-reported questionnaire about the type of toothpaste used among the study's participants. Thus, the objectives of this study were to document the types, ingredients and the cost of toothpaste available in Malaysia and to explore manufacturers' recommendation of toothpaste used and their labelling practice.

MATERIALS AND METHODS

This research has been approved by the Medical Ethics Committee, Faculty of Dentistry, University of Malaya [DF CO1804/0014(U)].

Toothpaste availability was identified from both online and offline (over-the-counter) markets. An online survey was conducted by searching through major online shopping websites such as Lazada, 11th Street, Shopee, Tesco, Watsons and Guardian. Keywords such as; 'toothpaste' AND/OR 'fluoridated' AND/OR 'non-fluoridated' were used during the online search. For the offline market, selected major pharmacies, supermarkets, family marts and traditional medicine stores in the Klang Valley area were visited. An assumption was made that various toothpastes available in Malaysia were available in the Klang Valley market. Identified toothpaste products from the search were recorded. The selection of the stores were based on popularity and logistic reasons. Data collection period was from 1 April to 7 August 2018.

The list of products from online and offline markets was compared, and duplicates were excluded from the sample. However, if the same brand manufactured both fluoridated and non-fluoridated products, both items were recorded. The information written on the packaging was recorded in Microsoft Excel spreadsheet; the country of manufacture, the date of expiry, the date of manufacture and price per item (*x*/gram), halal labelling and recommendation for use. Regarding the ingredients, the information on the packaging was also recorded to identify the descriptive names of fluoride compounds, their concentrations and the types of abrasives. The data were categorised into four groups for purposes of data presentation: fluoridated toothpaste for adults, non-fluoridated toothpaste for adults, fluoridated toothpaste for children and non-fluoridated toothpaste for children. Children toothpastes were identified based on age indication written on the box or by children-oriented packaging. Toothpastes that did not fall within the children's category were recorded as for adult use. To allow price comparison across brands, the price for 10 g was calculated. The cost of toothpastes were further re-coded into low (<RM1), medium (RM1–RM4) and high cost (RM4) for data presentation and further analysed by age group and fluoride content. The data were analysed descriptively using Microsoft Excel and SPSS version 23.

RESULTS

Manufacturers' Labelling Practice

In total, 176 brands of toothpastes were identified from this market survey. Most of the toothpaste available in the online market were also available in the physical stores. Amongst these, 47.98% were labelled as fluoridated toothpaste, where as 50.29% were labelled as non-fluoridated toothpaste or had no fluoride compound in their list of ingredients. About 25.43% brands were recommended for children, and the remaining 74.57% of toothpastes were recommended for adult use. Only 1.73% of the brands manufactured both fluoridated and non-fluoridated toothpaste. The majority of the products were available in paste/gel form, while a very small proportion (2.89%) were in powder form. The powder based products were only available for the adult category.

Regarding other labelling information, most of the toothpastes (65.91%) labelled the expiry date on their packaging. However, only 42.05% of the toothpaste manufacturers provided the information about the manufacturing date on the packaging. Only half of the products labelled both the expiring and manufacturing dates. About 38.07% indicated halal labelling on their packaging box. Summary results of manufacturers' labelling practice is shown in Table 1.

Most of the adult toothpastes were imported (63.57%), and only 33.33% of the brands sold in Malaysia were manufactured locally. Among the imported toothpastes, the majority was from the United States (14.63%), followed by China (12.20%) and India (10.97%). Around 3.1% did not specify the country of manufacture. Similar to adult toothpastes, most of the children toothpastes (59.09%) were imported from other countries, and only 36.36% were locally produced. There were 4.55% brands of toothpaste that did not state its manufacturing origin. The imported toothpastes were mainly from the United States (n=4), Australia (n=4), Italy (n=3), Thailand (n=2), Taiwan (n=2), Vietnam (n=2) and Russia (n=2).

Table 1 Summary results of manufacturers' labelling practice

Category		Adult		Children		Total	
		N	(%)	N	(%)	N	(%)
INGREDIENTS							
Fluoride compound	*Fluoridated toothpaste*						
	Sodium Fluoride (NaF)	18	27.27	9	45.00	27	31.40
	Sodium Monofluorophosphate (NaMFP)	40	60.61	8	40.00	48	55.81
	NaF + NaMFP	4	6.06	1	5.00	5	5.81
	Calcium Fluoride (CaF)	1	1.52	0	0.00	1	1.16
	Not stated	3	4.55	2	10.00	5	5.81
	Total	**66**	**37.5**	**20**	**11.36**	**86**	**48.86**
	Non-fluoridated toothpaste						
	Labelled fluoride-free	31	48.44	17	65.38	48	53.33
	Not stated	33	51.56	9	34.62	42	46.67
	Total	**64**	**36.36**	**26**	**14.77**	**90**	**51.11**
Labelling unit for fluoride concentration	Parts per million (ppm)	23	34.85	6	30.00	29	33.72
	Percentage (%), % w/w, % w/v*	12	12.18	3	15.00	15	17.44
	Not stated	31	46.97	11	55.00	42	48.84
	Total	**66**	**37.5**	**20**	**11.36**	**86**	**48.86**
Abrasive agents (present/absent)	Stated	121	93.08	42	91.30	163	92.61
	Abrasive free	1	0.77	1	2.17	2	1.14
	Not stated	8	6.15	3	6.52	11	6.25
	Total	**130**	**73.86**	**46**	**26.14**	**176**	**100**
Type of common abrasive compound	Silica	100	N/A	35	N/A	135	N/A
	Carbonates	51	N/A	7	N/A	58	N/A
	Phosphates	34	N/A	16	N/A	50	N/A
	Others	55	N/A	15	N/A	70	N/A
	Total	**240**	**N/A**	**73**	**N/A**	**313**	**N/A**
Herbal or organic ingredient	Yes	55	42.31	10	21.74	65	36.93
	No	75	57.69	36	78.26	111	63.07
	Total	**130**	**73.86**	**46**	**26.14**	**176**	**100**

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Table 1 (*Continued*)

Category		Adult		Children		Total	
		N	(%)	N	(%)	N	(%)
OTHER LABELLING INFORMATION							
Manufacturer	Imported	83	63.84	27	58.70	110	62.43
	Local	43	33.07	16	34.78	59	34.10
	Not stated	4	3.07	3	6.52	7	3.47
	Total	**130**	**73.86**	**46**	**26.14**	**176**	**100**
Manufacturing date	Stated	53	40.77	21	45.65	74	42.05
	Not stated	77	59.23	25	54.35	102	57.95
	Total	**130**	**73.86**	**46**	**26.14**	**176**	**100**
Expiry date	Stated	94	72.31	22	47.83	116	65.91
	Not stated	36	27.69	24	52.17	60	34.09
	Total	**130**	**73.86**	**46**	**26.14**	**176**	**100**
Halal labelling	Stated	54	41.54	13	28.26	67	38.07
	Not stated	76	58.46	33	71.74	109	61.93
	Total	**130**	**73.86**	**46**	**26.14**	**176**	**100**

*% w/w: percentage weight/weight, % w/v: percentage weight/volume
F: fluoride; N/A: information not available (total % was not calculated due to multiple abrasive agents found in each toothpaste)

Adult Toothpaste

Table 2 shows the results for adult fluorided toothpastes in the Malaysian market. About half of the toothpastes (50.77%) contained fluoride, based on the packaging box. Different units were used to indicate the fluoride content such as percentage (%), parts per million (ppm), percentage weight/weight (% w/w) and percentage weight/volume (% w/v). The most common fluoride compound used was sodium monofluorophosphate, NaMFP (60.61%), followed by sodium fluoride, NaF (27.27%) and calcium fluoride, CaF_2 (1.52%). Although some manufacturers claimed that their products contained fluoride, 31 brands did not state the fluoride concentration. Apart from fluoride, abrasive agents used in the toothpastes were also noted. The most common abrasive agents were silica, calcium, carbonates and phosphates. A small proportion of the identified toothpastes had calcium-based abrasives with sodium fluoride.

The remaining 49.23% of the samples were labelled as non-fluoridated toothpaste or had no fluoride compound in their list of ingredients. Results from the analysis of adult non-fluoridated toothpastes are presented in Table 3. The most common active abrasive agents for non-fluoridated toothpastes were silica and calcium carbonates. It was also noted that non-fluoridated toothpastes were mostly marketed as herbal or organic products. Some of the organic-based ingredients included were *miswak*, natural mint, tea tree oil, coconut oil, olive oil, aloe vera, nutmeg and neem.

Children Toothpaste

Among the children toothpastes, 43.48% were fluoridated, and the remaining 56.52% brands were non-fluoridated. The results from the analysis of children toothpastes are presented in Tables 4 and 5. The most common fluoride compound used in childrens toothpaste were sodium fluoride, NaF (45%) and sodium

Table 2 Results of the analyses of adult fluoride toothpaste in the Malaysian market

ID*	Manufacturer	Abrasive agents	Type of F	F concentration	Price/10 g (RM)
1	Spain	PP, silica TPPP	NaF	NaF 0.22% (995 ppm F-)	6.30
2	USA	Silica	NaF	NaF 0.21% (950 ppm F-)	1.40
3	China	$NaHCO_3$, silica	Mention F only	Not stated	0.50
4	USA	$Al(OH)_3$, silica, TPPP	NaMFP	Not stated	2.70
5	UK	$NaHCO_3$, $Na_2H_3CO_6$, silica, TPPP	NaF	NaF 0.243%	2.50
6	Korea	Silica, TPPP	NaMFP, NaF	Not stated	0.80
7	Korea	DCPD, silica	NaMFP	Not stated	1.60
8	USA	$CaCO_3$, CaO_2, SiO_2, SPP, silica	NaMFP	NaMFP 0.15% W/V	4.60
9	Malaysia	$CaCO_3$, $NaHCO_3$, Na_2CO_3, silica, TSPP	NaMFP	Not stated	0.20
10	Indonesia	$CaCO_3$, silica	NaMFP, NaF	NaMFP 0.76% + NaF 0.01%	0.30
11	Indonesia	Silica	NaF	Not stated	0.40
12	China	DCPD, TSPP	NaMFP	NaMFP 1.1% W/W (1,450 ppm F-)	0.40
13	China	PSTP, silica, TPPP	NaF	Not stated	1.20
14	Malaysia	$CaCO_3$, silica	NaMFP	NaMFP 0.76% W/W	0.30
15	USA	Mica, SHMP, silica, TSP	NaF	NaF 0.243% (0.16% W/V F-)	5.00
16	Switzerland	CA, DSP, silica	NaF	NaF 1,450 ppm F-	4.00
17	China	Mica, PSTP, silica, TSPP	NaF	Not stated	0.80
18	China	DCPD, DCP, TSPP	NaMFP	Not stated	0.60
19	India	$CaCO_3$, silica, TSPP	NaMFP	NaMFP 0.76% W/W (1,000 ppm)	1.15
20	Spain	CGP, SAP, silica	NaMFP	NaMFP 1,460 ppm F-	2.60
21	Dubai	Silica	Not stated	Not stated	1.20
22	Malaysia	DCP, silica	NaMFP	Not stated	0.20
23	Thailand	DSP, SHMP, silica	NaMFP, NaF	Not stated	0.80
24	China	$CaCO_3$, silica	NaMFP	NaMFP 0.7%	0.40
25	Malaysia	$CaCO_3$, silica	NaMFP	Not stated	0.20
26	Indonesia	PSTP, silica	NaMFP	Not stated	0.30
27	China	$CaCO_3$, silica	NaMFP, NaF	NaMFP, NaF (1,000 ppm F-)	0.30
28	UK	None	NaF	Not stated	1.60
29	Malaysia	DCPD, TSPP	NaMFP	Not stated	1.35
30	Spain	Silica	NaF	NaF 1,450 ppm F-	4.90
31	India	CA, silica	CaF	CaF 500 ppm F-	0.40
32	Malaysia	$CaCO_3$, silica	NaMFP	Not stated	0.30
33	Malaysia	$CaCO_3$, silica	NaMFP	Not stated	0.30

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Table 2 (*Continued*)

ID*	Manufacturer	Abrasive agents	Type of F	F concentration	Price/10 g (RM)
34	Italy	Silica, TPPP	NaMFP	NaMFP 0.72% (950 ppm F-)	1.90
35	Myanmar	$CaCO_3$, MAS, NaHCO3, silica	NaMFP	Not stated	0.50
36	Taiwan	Cleansing formula, Lizey Plus- X-vc whitening factor, Lizey SmoCure - X-vc teeth whitening factor	NaMFP	Not stated	6.70
37	Pakistan	None	NaMFP	NaMFP 1,400 ppm F-	1.40
38	USA	Silica, TPPP, TSPP	NaF	NaF 0.234% W/W	1.55
39	Malaysia	DCP	NaMFP	Not stated	0.50
40	India	$CaCO_3$, SDHP, silica	NaMFP	NaMFP 100 ppm F-	0.40
41	Malaysia	DCPD, silica, TSPP	NaMFP	Not stated	1.40
42	UK	DCP, glucose oxidase, silica, lactoperoxidase, lysozymes	NaMFP	NaMFP 0.76% W/W (1,000 ppm F-)	3.20
43	Germany	Silica, sodium citrate, ZC	NaF	NaF 1,450 ppm F-	1.30
44	Thailand	$NaHCO_3$	NaF	NaF 0.221% W/W (1,000 ppm F-)	1.20
45	India	None	Mention F only	F content ~924 ppm	0.45
46	India	$CaCO_3$	Mention F only	F content ~924 ppm	0.90
47	Singapore	Alumina, $CaCO_3$, $NaHCO_3$, silica	NaMFP	NaMFP 0.80% W/W (1,050 ppm F-)	1.55
48	Australia	CPP, DCP, silica, SP, TSP	NaMFP	NaMFP 0.76% W/W	2.80
49	Indonesia	$CaCO_3$, silica	NaMFP	Not stated	0.20
50	Spain	Silica, TPPP	NaF	NaF 0.33% W/W	1.65
51	Malaysia	$CaCO_3$, tetrasodium EDTA, TSPP	NaMFP	Not stated	0.40
52	Thailand	Silica	NaF	NaF 0.221% W/W (1,000 ppm)	0.90
53	USA	PSTP, silica	NaMFP	Not stated	1.90
54	Malaysia	CP, DCPD, Silica, TSPP	NaMFP	Not stated	0.20
55	Malaysia	$CaCO_3$, silica	NaMFP	Not stated	0.40
56	China	CSPS, silica	NaF	NaF 0.3152% W/W (1,450 ppm F-)	1.40
57	Vietnam	$CaCO_3$, potassium citrate, silica	NaMFP	NaMFP 1,450 ppm F-	0.40
58	Indonesia	$CaCO_3$	NaMFP	Not stated	n/a
59	Indonesia	Not stated	NaMFP	Not stated	n/a
60	Japan	silica	NaF	Not stated	1.10
61	Malaysia	Not stated	NaMFP	NaMFP 0.76%	1.20
62	Malaysia	$CaCO_3$, pyrophosphate, silica	NaMFP	Not stated	0.20
63	Malaysia	$CaCO_3$, pyrophosphate, silica	NaMFP	Not stated	0.10
64	USA	Silica, TPPP, TSPP	NaF	NaF 0.24%	4.20
65	Japan	CHP, silica	NaF	Not stated	8.75

(*Continued on next page*)

Table 2 (*Continued*)

ID*	Manufacturer	Abrasive agents	Type of F	F concentration	Price/10 g (RM)
66	Malaysia	$CaCO_3$, TSPP	NaMFP	NaMFP 0.76%	0.50
67	Australia	$CaCO_3$, silica	NaMFP	NaMFP 0.76% W/W (1,000 ppm F-)	1.80
68	Malaysia	$CaCO_3$, silica	NaMFP	Not stated	0.70
69	Spain	PP, silica, TPPP	NaF	NaF 1,450 ppm F-	6.70
70	Malaysia	$CaCO_3$, TSPP	NaMFP	Not stated	0.30
71	Japan	Alumina, $CaCO_3$, silica	NaMFP	NaMFP 1,000 ppm F-	0.50

*Product ID: The list of all toothpaste brands is presented in Appendix 1.
F: fluoride
Type of fluoride: NaMFP, sodium monofluorophosphate; NaF, sodium fluoride; CaF_2, calcium fluoride.
Abrasive agent: $CaCO_3$, calcium carbonate; PP, potassium pyrophosphate; TPPP, tetrapotassium pyrphosphate; $NaHCO_3$, sodium bicarbonate; $Al(OH)_3$, Aluminium hydroxide; $Na_2H_3CO_6$, sodium percarbonate; DCPD, dicalcium phosphate dihydrate; CaO_2, calcium peroxide; SiO_2, silicon dioxide; SPP, sodium pyrphophate; TSPP, tetrasodium pyrophosphate; PSTP, pentasodium triphosphate; SHMP, sodium hexametaphosphate; TSP, trisodium phosphate; CA, citric acid; DSP, disodium phosphate; DCP, dicalcium phosphate; CGP, calcium glycerophosphate; SAP, sodium ascorbyl phosphate; MAS, magnesium aluminium silicate; SDHP, sodium dihydrogen phosphate; CPP, calcium pyrophosphate; SP, sodium phosphate; CP, calcium phosphate; CSPS, calcium sodium phosphosilicate; CHP, calcium hydrogen phosphate; ZC, zinc citrate.

Table 3 Results of the analyses of adult non-fluoridated toothpastes in the Malaysian market

ID*	Manufacturer	Abrasive Agents	Price/ 10 g (RM)	ID*	Manufacturer	Abrasive Agents	Price/ 10 g (RM)
72	Not stated	Not stated	4.10	91	India	Silica	0.40
73	Not stated	MPP $CaCO_3$, $NaHCO_3$, silica	0.55	92	USA	$CaCO_3$, silica	3.00
74	Malaysia	Silica	0.70	93	Malaysia	$CaCO_3$, silica	0.40
75	India	Silica	0.80	94	Malaysia	DCP	1.30
76	Thailand	Silica	2.60	95	USA	Silica	3.80
77	China	Mica, silica	1.00	96	Malaysia	Silica	1.10
78	Italy	Silica, TPPP	3.35	97	Australia	$CaCO_3$, DCPD, silica	1.10
79	Malaysia	Silica	1.00	98	Malaysia	Silica	1.50
80^	Not stated	$CaCO_3$, charcoal powder, PP, silica, ZC	1.40	99	Malaysia	Silica	0.30
81	Malaysia	DCP	1.80	100	Malaysia	$CaCO_3$, silica	0.25
82^	Malaysia	Alum	0.50	101	Malaysia	$CaCO_3$, silica	0.40
83	China	DCP, TSPP	0.20	102^	India	None	1.70
84	France	Silica	1.80	103	India	Silica	0.60
85	UAE	$CaCO_3$, silica	0.50	104	Malaysia	DCP, silica, TSPP	0.75
86	UAE	$CaCO_3$, silica	0.55	105	India	$CaCO_3$, silica	0.40
87	Thailand	$CaCO_3$, MAS, $NaHCO_3$, silica, ZC	3.00	106	Malaysia	Silica, TSP	2.50
88	Malaysia	DCP, silica	0.80	107	Germany	$CaCO_3$, silica	2.50
89	Thailand	None	1.60	108	New Zealand	$CaCO_3$	2.20
90	India	Silica	0.40	109	New Zealand	$CaCO_3$, MAS, silica	3.00

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Table 3 (*Continued*)

ID*	Manufacturer	Abrasive Agents	Price/ 10 g (RM)	ID*	Manufacturer	Abrasive Agents	Price/ 10 g (RM)
110	Malaysia	$CaCO_3$, silica, TSP	2.50	128	New Zealand	$CaCO_3$, MAS, silica	1.90
111	Italy	Silica, SC	6.40	129	Malaysia	$CaCO_3$, TSPP	0.80
112	China	$CaCO_3$, silica	0.90	130	Malaysia	DCP, silica, TSPP	2.60
113	UAE	$CaCO_3$, silica	0.30	131	Japan	$CaCO_3$, silica	1.75
114	Malaysia	Silica	0.50	132	Russia	Mica, silica	2.70
115	Malaysia	$CaCO_3$, CP, DCPD, silica	0.30	133	Malaysia	$CaCO_3$, silica	2.10
116	Malaysia	$CaCO_3$, silica	0.45	134	Malaysia	$CaCO_3$,	0.30
117	Italy	PC, silica, ZC	2.50	135	Malaysia	DCPD, silica	1.60
118	China	Bamboo charcoal, silica	0.80	136	Malaysia	None	9.30
119	Malaysia	$CaCO_3$, silica	0.30	137^	Malaysia	None	n/a
120	Malaysia	DCPD, silica, TSPP	1.40	138	Malaysia	DCPD, silica	2.10
121	Not stated	DCPD, silica, TSPP	1.30	139	India	$CaCO_3$	0.75
122	Malaysia	DCPD, silica	0.90	140^	India	None	1.00
123	USA	$CaCO_3$, silica	2.50	141	Malaysia	$CaCO_3$, silica, TSPP	1.50
124	Korea	Silica	2.30	142	Taiwan	Activated carbon, CP	1.80
125	Malaysia	$CaCO_3$, DCPD, silica, TSPP	0.65	143	USA	$NaHCO_3$, silica	1.40
126	Malaysia	DCP, TSPP	0.30	144	USA	$CaCO_3$, $NaHCO_3$	4.10
127	Thailand	$CaCO_3$	2.40				

*Product ID: The list of all toothpaste brands is presented in Appendix 1.
^Powder-based product
Abrasive agents: $CaCO_3$ calcium carbonate; PP, potassium pyrophosphate; TPPP, tetrapotassium pyrophosphate; $NaHCO_3$, sodium bicarbonate; DCPD, dicalcium phosphate dihydrate; TSPP, tetrasodium pyrophosphate; TSP, trisodium phosphate; DCP, dicalcium phosphate; MAS, magnesium aluminium silicate; CP, calcium phosphate; ZC, zinc citrate; SC, sodium citrate; PC, potassium citrate.

monofluorophosphate, NaMFP (40%) as presented in Table 4. Only one brand (5%) claimed to have included both NaF and NaMFP in the ingredients. Similar to adults toothpastes, there was a lack of standardisation regarding labelling fluoride concentration units on the display packaging such as using percentage (%), parts per million (ppm), percentage weight/weight (% w/w) and percentage weight/volume (% w/v).

Abrasive agents were also used in the children toothpastes. Compounds of silica were identified as the most commonly used agent in the ingredients, followed by compounds of phosphates and carbonates. There was one toothpaste that claimed to be of purely organic ingredients and contained no abrasive agents. Furthermore, three brands of toothpastes did not mention any abrasive agents on their packaging.

Cost of Toothpaste

Toothpastes were marketed at different weights, and the cost varied across brands. The adult toothpastes were marketed with product weights ranged from 25 g to 250 g while children toothpastes ranged from 19 g to 114 g. To allow consistency of reporting and comparing across different brands, the price for each product was recalculated at 10 g. The cost of toothpaste varied greatly

Table 4 Results of the analyses of children fluoride toothpaste in the Malaysian market

No.	Brand	Manufacturer	Abrasive agents	Type of F	F concentration	Price/ 10 g (RMs)
1	Amway Glister Kids Toothpaste	USA	$NaHCO_3$, silica	NaF	Not stated	1.70
2	Buds™ Children's Toothpaste With Fluoride	Australia	Silica	NaF	NaF 0.05% W/W	5.80
3	Chicco Dentifricio Toothpaste	Italy	Silica	NaF	NaF 1000ppm F-	3.60
4	Colgate® Spiderman Bubble Fruit Flavour	Thailand	Silica, TSPP	NaF	Not stated	0.80
5	Darlie Bunny Kids Toothpaste	China	CGP,silica, TSPP	NaMFP	NaMFP 0.456% W/W (600ppm F)	0.80
6	Econsave Choice Children Toothpaste	Malaysia	DCPD, silica	NaMFP	Not stated	0.40
7	Fluocaril Kids 6+ Years Green Toothpaste	Thailand	Silica	NaMFP and NaF	Not stated	1.25
8	Frezyderm Sensiteeth Kids Toothpaste 500ppm	Malaysia	Not stated	NaMFP	NaMFP 500ppm F-	4.00
9	G.U.M Toothpaste for 2–6 years	Japan	DSP, silica, SP	NaF	Not stated	2.10
10	Garfield Strawberry Flavour Children Toothpaste	Malaysia	$CaCO_3$, silica	Stated F only	Not stated	0.60
11	Giant Kids Toothpaste	Malaysia	DCPD	NaMFP	Not stated	0.40
12	Ipana Bucky Beaver Bubble Gum Children Fluoride Toothpaste	Malaysia	DCPD,silica, TSPP	NaMFP	NaMFP 0.76% (F- 0.1% w/w)	4.20
13	Jordan Step 1 Kids Toothpaste 0–5 years	Malaysia	Silica, TSP	NaF	NaF 500 ppm F-	1.20
14	Koala Pals® Fluoride Tooth Gel	USA	CA,$NaHCO_3$, silica	NaF	NaF 0.24% w/w (F- 0.15% w/v)	1.40
15	Kodomo Kids Dental Set	Japan	Silica	NaF	NaF 500ppm F-	1.45
16	Kodomo Lion Orange Kids Toothpaste	Japan	Silica	NaF	NaF 500ppm F-	0.50
17	KU.KU Duckbill 1087 Baby Toothpaste	Taiwan	Silica	Stated F only	Not stated	2.40
18	Natura House Cucciolo Red Fruits Toothpaste	Italy	Silica	NaF	Not stated	5.80
19	Oral 7 Kids Toothpaste	UK	Silica, lysozyme	NaMFP	NaMFP 0.76% W/W (1000ppm F)	8.60
20	Pro Dental B Junior Fruity Toothpaste	Malaysia	DCPD	NaMFP	Not stated	1.10
21	Tesco Kids Bubble gum Toothpaste	Malaysia	$CaCO_3$, silica	NaMFP	Not stated	0.35
22	Tesco Steps 0-2 years Gentle Mint Toothpaste	China	Silica, mica	NaF	NaF 0.22% w/w (1000ppm)	0.60

across brands ranging from low, medium to high cost. In general, the price of toothpastes per 10 g ranged from RM0.10 to RM9.50 with mean of RM1.90 (S.D. 1.93). When looking into toothpastes with fluoride content, the price of fluoridated toothpastes were lower than the non-fluoridated toothpastes as shown in Table 6. Broadly similar pattern was observed for both children and adult toothpaste.

Table 5 Results of the analyses of children non-fluoridated toothpaste in the Malaysian market

No.	Brand	Manufacturer	Abrasive Agents	Price/ 10 g (RM)
1	Aquafresh First Teeth Baby Toothpaste	USA	Silica, SC	7.80
2	Coslys Junior Organic Toothpaste	France	CA, mica, silica	1.60
3	Fiffy Kids Toothpaste	Malaysia	$CaCO_3$, DCPD, silica, TSDP	0.70
4	FrezyDerm SensiTeeth First Toothpaste 6+ months	Not stated	Not stated	5.00
5	Grants Kid Natural Toothpaste	Australia	$CaCO_3$, DCPD, silica	2.30
6	Guardian Infant Oral Set	Malaysia	Silica	3.70
7	Hito Children's Toothpaste with Xylitol	Not stated	Mica, silica	4.60
8	Intelligent Children Toothpaste with Natural Enzymes	Taiwan	Lactoperoxidase, lysozyme	4.70
9	Jack N' Jill Natural Toothpaste	Australia	Silica	6.00
10	Kaydean Natural Toothpaste	Malaysia	Not stated	4.50
11	LeRoselle Kids Toothpaste	Malaysia	DCP, silica, TSPP	0.90
12	Little Innoscents Milky Whites OrganicToothpaste	Australia	$CaCO_3$, $NaHCO_3$	3.80
13	Logodent Zahngel Spearmint Kids Toothpaste	Germany	$NaHCO_3$, silica	6.90
14	Morning Kiss Toothpaste for Kids 3-12 Years	Malaysia	CGP, silica, SMS	0.75
15	Mu'min Junior Toothpaste	Malaysia	DCPD, silica, TSPP	0.40
16	NeBiolinaBebé First Teeth Toothpaste	Italy	Silica	5.50
17	Oral 7 for Tiny Teeth Gel	Ireland	Lactoperoxidase, silica	9.50
18	Patanjali Dant Kanti Junior Toothpaste	India	None	0.40
19	Perioe Kids Toothpaste	Korea	Silica	1.50
20	Pigeon Children Toothpaste	Indonesia	DCPD, TMP	1.60
21	Pureen Kids Toothpaste	Malaysia	CPP, DCPD, silica, TSPP	0.70
22	R.O.C.S Baby Toothpaste Mild Care	Russia	DCPD, silica	4.70
23	Raiya Junior Children Toothpaste	Malaysia	DCPD:	0.55
24	Splat Junior Natural Toothpaste for Kids 2-6 Years	Russia	Lactoperoxidase, silica	2.70
25	Splat Junior Natural Toothpaste for Kids 6-11 Years	Russia	Lactoperoxidase, mica, silica	2.70
26	Xylin Toothpaste for Kids	Malaysia	$CaCO_3$, silica, TSPP	1.20
27	Young Living KidScents Slique Toothpaste	USA	$CaCO_3$, $NaHCO_3$	2.90

Abrasive agents: $CaCO_3$ calcium carbonate; $NaHCO_3$, sodium bicarbonate; DCPD, dicalcium phosphate dihydrate; TSPP, tetrasodium pyrophosphate; CA, citric acid; DCP, dicalcium phosphate; CGP, calcium glycerophosphate; CPP, calcium pyrophosphate; PP, pyrophosphate; SC, sodium citrate; TSDP, tetrasodium diphosphate; SMS, sodium magnesium silicate; TMP, trimagnesium phosphate.

Table 6 The cost of toothpaste by age group and fluoride content

Category	Fluoridated			Non-fluoridated		
	Adults N (%)	Children N (%)	Total N (%)	Adults N (%)	Children N (%)	Total N (%)
<RM1.00 (low)	35 (50.7)	8 (36.4)	43 (47.3)	33 (45.8)	7 (25.9)	40 (40.4)
RM1.00–RM4.00 (med)	26 (37.7)	10 (45.5)	36 (39.6)	35 (48.6)	10 (37.0)	45 (45.4)
>RM4.00 (high)	8 (11.6)	4 (18.2)	12 (13.2)	4 (5.6)	10 (37.1)	14 (14.1)

Manufacturers' Recommendation for Toothpaste Use

The majority of manufacturers provided prevention advice such as toothbrushing frequency, amount of toothpaste to be used, post-brushing advice, brushing technique, dietary sugar advice and frequency of dental visits. Table 7 summarises the manufacturers' instruction of toothpaste use based on their packaging label.

Some manufacturers provided recommendation on toothpaste use. For example, brushing twice daily (36.36%), pea-sized amount of toothpaste for children (36.36%) and adult supervision when children are brushing (14.20%). Some brands recommended brushing after meals. Variation of messages was also observed regarding the amount of toothpaste to be used and post-brushing advice. For example, 11.36% brands suggested that the amount of toothpaste for adults was equal to the full toothbrush bristle length, and only 1.7% brands recommend that adults use a pea-sized amount. Regarding post-brushing advice, about 40.77% adults toothpaste brands and 63.04% children toothpaste brands incorporated instructions to spit-out

Table 7 Manufacturers' recommendation of toothpaste use

	Description	Adults		Children		Total N (%)
		F N (%)	NF N (%)	F N (%)	NF N (%)	
Frequency of toothbrushing	Twice (2x)	30 (23.08)	13 (10.00)	8 (17.39)	13 (28.26)	64 (36.36)
	3 times (3x)	7 (5.38)	0	1 (2.17)	0	8 (4.55%)
	>3x or after meals	1 (0.77)	8 (6.15)	1 (2.17)	1 (2.17)	11 (6.25)
	Combined (brush at least 2x and brush after meals)	12 (9.23)	8 (6.15)	4 (8.70)	0	24 (13.64)
Amount of toothpaste	Whole bristle length	16 (12.31)	4 (3.08)	0	0	20 (11.36)
	Pea-sized (children)	35 (26.9)	8 (6.15)	13 (28.26)	8 (17.39)	64 (36.36)
	Pea-sized (adult)	0 (0.00)	3 (2.31)	N/A	0	3 (1.70)
	Small amount	0 (0.00)	1 (0.77)	2 (4.35)	6 (13.04)	9 (5.11)
	Others	3[a] (2.31)	0	1[b] (2.17)	6[c] (13.04)	10 (5.68)
Post-brushing advice	Rinse	21 (16.15)	12 (9.23)	11 (23.91)	11 (23.91)	55 (31.25)
	Rinse thoroughly	2 (1.54)	3 (2.31)	1 (2.17)	0	6 (3.41)
	Do not swallow/spit out	40 (30.77)	13 (10.00)	18 (39.13)	11 (23.91)	82 (46.59)
Supervised toothbrushing		Not relevant		15 (32.61)	10 (21.74)	25 (14.20)
Not stated (brand without any recommendation/ guideline of toothpaste use)		8 (6.15)	24 (18.46)	5 (10.87)	0	37 (21.02)

[a]1 cm (n=2), 2.5 cm (n=1) of toothpaste, [b]1 cm of toothpaste, [c]small amount (n=6) of toothpaste.
F, fluoridated; NF, non-fluoridated toothpaste.

after use and not to swallow the toothpaste. However, there were adult toothpaste (25.38%) and children toothpaste (47.82%) brands that incorporated instruction to rinse after brushing.

Of all the identified toothpastes in the present study, there were brands of adult toothpaste (24.61%) and brands of children toothpaste (10.87%) that did not specify any guidelines of its use.

DISCUSSION

In general, about half of the toothpastes (47.98%) identified in this survey were fluoridated, and the remaining toothpastes were non-fluoridated (50.29%). The findings indicate the growing number of non-fluoridated toothpastes in the Malaysian market (Musa and Saub, 1998). Therefore, continuous efforts to improve public awareness on the use of fluoridated toothpaste is crucial. This is particularly important in states without fluoridated water such as Kelantan and areas that have ceased providing fluoridated water such as Pahang (in 2012) (Ministry of Health Malaysia, 2018). Hence, the population approach to caries prevention in these areas mainly rely on fluoridated toothpaste (O'Mullane *et al.*, 2016; Petersen and Ogawa, 2016).

There was a lack of standardisation regarding labelling practices among manufacturers. For example, about 48.84% did not indicate the concentration of fluoride contained in the paste. Of those with fluoride content, some provided information of fluoride concentration in % w/w, % w/v instead of ppm. Similar findings have been reported by previous local studies (Musa and Saub, 1998; Gundavarappa *et al.*, 2017). Poor labelling practices may confuse the consumers to make an informed choice of toothpaste. In addition, dental professionals may also be unaware of the concentration of fluoride present in the toothpastes when presented in different units as many evidence-based recommendations use the ppm unit. On the basis of the available information, it may also cause difficulty for a dentists to make specific recommendations to patients.

There was a wide range of toothpastes with different fluoride concentrations available in the local market. For example, adult toothpastes had fluoride concentrations ranging from 500 to 1,460 ppm, while children toothpastes had fluoride ranging from 500 to 1,000 ppm. Also, there were a number of products with low fluoride concentration (<500 ppm). Evidence suggests the use of fluoridated toothpaste with a minimum concentration of 1,000 ppm is effective in caries prevention (Marinho *et al.*, 2003). However, there is still variation in the recommended fluoride concentration in different countries, particularly for children. Many developed countries like the United Kingdom and New Zealand no longer recommend the use of low fluoride toothpaste at 500–600 ppm for children (Ministry of Health, New Zealand, 2009; Public Health England, 2017). In contrast, Australian guidelines recommend the use of low fluoride toothpaste (400–550 ppm) for children aged 18 months to 6 years (Spencer, 2006).

Apart from fluoride concentration, the quantity of toothpaste that should be used has been heavily debated in the literature. The use of a smear (≤3 years) and pea-sized amount (>3 years) of toothpaste are recommended based on the Malaysian fluoride guidelines (Malaysian Dental Council, 2009). However, some instructions on the toothpaste packaging did not comply with the national guideline. Certain manufacturers provided misleading messages to the consumer on toothpaste use by using pictorial artwork that implies that the toothpaste used should 'cover the whole length of the bristles'. It is unhelpful to have a disparity between exhortations to use small amounts, while the images depict generously applied toothpaste to the toothbrush (Murray *et al.*, 2003). Evidence reports that the amount of toothpaste used could significantly

affect total fluoride ingestion (Guha-Chowdhury *et al.*, 1996). An excessive amount of fluoride ingestion during critical periods of tooth development may increase the risk of developing dental fluorosis.

Based on the present data, there was a wide range of toothpaste prices for different brands ranging from a low, medium to high cost. In this study, the cost classification for analysis purposes was arbitrary as no reference is available in the literature on this subject of interest. Broadly similar patterns were observed for both fluoridated and non-fluoridated toothpaste. However, some of the non-fluoridated toothpaste were marketed as a high-end product, which contributed to a higher mean price for non-fluoridated toothpaste than fluoridated toothpaste. There is no clear pattern between imported and local products regarding cost. Most of the non-fluoridated toothpastes were marketed as herbal-based or organic products. Similar findings were reported by other authors regarding the toothpastes available in India (Khairnar *et al.*, 2017).

There was a small proportion of the identified toothpastes which contained calcium based abrasives e.g. calcium carbonate ($CaCO_3$), dicalcium phosphate dihydrate (DCPD), calcium glycerophosphate (CGP). It is important to note that for toothpaste with sodium fluoride and stannous fluoride, the fluoride compounds are not compatible with calcium-containing abrasives (Benzian *et al.*, 2012). These abrasive agents may deactivate some of the fluoride present. In contrast, for fluoridated toothpastes that use sodium monofluorophosphate [NaMFP (Na_2PO_3F)], the PO_3F^{2-} components have better compatibility with abrasive agents that contain calcium. This is because in PO_3F^{2-}, the fluoride is firmly bound to the phosphate and therefore cannot be bound to soluble calcium to form insoluble calcium fluoride. These findings have been confirmed by many laboratory studies (Benzian *et al.*, 2012; Carrera *et al.*, 2012; Vorster *et al.*, 2018). Therefore, it is an important criterion to be considered to determine total and free fluoride content in the toothpastes available in Malaysia for future research.

The lack of enforcement on guidelines for packaging and labelling of toothpastes in Malaysia may increase the chance for false claims toothpastes. Relevant authorities such as the Ministry of Health and the Malaysian Dental Association should play a fundamental role in monitoring these products. This is not only to ensure the product safety and efficacy, but also to provide a clear guideline and strong enforcement on packaging and labelling of toothpaste in Malaysia. This is crucial to ensure effective delivery of fluoride through toothpaste. In the United States, it is mandatory for manufacturers to declare and accurately label the fluoride content of toothpaste (FDA, 1995).

Results from the present study should be interpreted with some limitations. Firstly, it is not possible to differentiate between genuine and fake products during the data collection period. It is acknowledged that counterfeit products are often identical in terms of labelling and packaging that even experts have difficulty in distinguishing the fake products (Benzian *et al.*, 2012). Thus, it is possible that some of the samples included in the study were counterfeit products. Secondly, the toothpaste samples included in this study were only limited to the selected online and offline markets and there is possibility for some toothpastes to have been missed. Results should not be generalised to other samples of the same brands or the overall toothpaste brand. Thirdly, fluoride content in this study was solely identified based on the labelling on the display box. Further laboratory studies are needed to determine total and free fluoride content in the toothpaste. In addition, clear advice that comply with evidence based recommendations about toothpaste use on the label is highly recommended to benefit the consumers.

CONCLUSION

There were many types of toothpastes available in the Malaysian market with a growing number of non-fluoridated toothpaste. Manufacturers' recommendations for toothpaste use varied, with a small proportion following evidence-based recommendations. The cost of toothpaste varied greatly across brands ranging from low (RM <1), medium (RM1–RM4) to high (RM >4) cost. There was a lack of standardisation regarding labelling practices of various toothpaste packaging, which may put consumers and dental health professionals at a disadvantage. Findings from this study may be useful to advocate for standardised guidelines for labelling of toothpaste which will benefit the consumer. The comprehensive list of fluoridated and non-fluoridated toothpastes may be useful for clinicians to provide specific advice based on their patient's needs and for research purposes.

REFERENCES

Aoun A, Darwiche F, Al Hayek S, Doumit J (2018). The fluoride debate: The pros and cons of fluoridation. *Prev Nutr Food Sci*, **23**(3): 171–180. https://doi.org/10.3746/pnf.2018.23.3.171

Benzian H, Holmgren C, Buijs M, van Loveren C, van der Weijden F, van Palenstein Helderman W (2012). Total and free available fluoride in toothpastes in Brunei, Cambodia, Laos, the Netherlands and Suriname. *Int Dent J*, **62**(4): 213–221. https://doi.org/10.1111/j.1875-595X.2012.00116.x

Canadian Paediatric Society (2002). The use of fluoride in infants and children. *Paediatr Child Health*, 7(8): 569–572. https://doi.org/10.1093/pch/7.8.569

Carrera CA, Giacaman RA, Muñoz-Sandoval C, Cury JA (2012). Total and soluble fluoride content in commercial dentifrices in Chile. *Acta Odontol Scand*, **70**(6): 583–588. https://doi.org/10.3109/00016357.2011.640287

Food and Drug Administration (FDA) (1995). Anticaries drug products for over-the-counter human use; Final monograph. *Fed Reg*, **60**(194): 52474–52510.

Frencken JE, Sharma P, Stenhouse L, Green D, Laverty D, Dietrich T (2017). Global epidemiology of dental caries and severe periodontitis: A comprehensive review. *J Clin Periodontol*, **44**(Suppl 18): S94–S105. https://doi.org/10.1111/jcpe.12677

Goldman AS, Yee R, Holmgren CJ, Benzian H (2008). Global affordability of fluoride toothpaste. *Global Health*, **4**:7. https://doi.org/10.1186/1744-8603-4-7

Guha-Chowdhury N, Drummond BK, Smillie AC (1996). Total fluoride intake in children aged 3 to 4 years: A longitudinal study. *J Dent Res*, **75**(7): 1451–1457. https://doi.org/10.1177/00220345960750070401

Gundavarappa KC, Ramachandra SS, Dicksit DD, Gupta VV (2017). The specifications and ingredients found in commercially available toothpastes. *Makara J Health Res*, **21**(3): 82–86.

Khairnar MR, Dodamani AS, Karibasappa GN, Naik RG, Deshmukh MA (2017). Efficacy of herbal toothpastes on salivary pH and salivary glucose: A preliminary study. *J Ayurveda Integr Med*, **8**(1): 3–6. https://doi.org/10.1016/j.jaim.2016.12.004

Malaysian Dental Council (2009). *Position Document: Use Of Fluorides In Malaysia*. Kuala Lumpur: Malaysian Dental Council.

Marinho VC, Higgins JP, Sheiham A, Logan S (2003). Fluoride toothpastes for preventing dental caries in children and adolescents. *Cochrane Database Syst Rev*, (1): CD002278.

Ministry of Health Malaysia (2018). *Annual Report 2016: Oral Health Programme, Ministry of Health Malaysia*, pp. 28. Retrieved 5 December 2018, from http://ohd.moh.gov.my/images/pdf/annual_rpt/annual_rpt16.pdf

Ministry of Health, New Zealand (2009). *New Zealand Guidelines Group. Guidelines for the Use of Fluorides*. Wellington: Ministry of Health, New Zealand.

Murray JJ, Nunn JH, Steele JG (eds.) (2003). *The Prevention of Oral Disease*, 4th edn. Oxford: Oxford University Press.

Musa S, Saub R (1998). Toothpastes available in the Malaysian market. *Ann Dent Univ Malaya*, **5**(1): 45–48. https://doi.org/10.22452/adum.vol5no1.9

O'Mullane DM, Baez RJ, Jones S, Lennon MA, Petersen PE, Rugg-Gunn AJ *et al.* (2016). Fluoride and oral health. *Community Dent Health*, **33**(2): 69–99. https://doi.org/10.1922/CDH_3707O'Mullane31

Opeodu OI, Gbadebo SO (2017). Factors influencing choice of oral hygiene products by dental patients in a Nigerian Teaching Hospital. *Ann Ib Postgrad Med*, **15**(1): 51–56.

Petersen PE, Ogawa H (2016). Prevention of dental caries through the use of fluoride – the WHO approach. *Community Dent Health*, **33**(2): 66–68. https://doi.org/10.1922/CDH_Petersen03

Public Health England (2017). *Delivering Better Oral Health: An Evidence-Based Toolkit For Prevention*, 3rd edn. London: Public Health England.

Sandier M (1997). *The Regulation of Toothpaste*. Retrieved 2 December 2018, from http://nrs.harvard.edu/urn-3:HUL.InstRepos:8846762.

Spencer AJ (2006). The use of fluorides in Australia: Guidelines. *Aust Dent J*, **51**(2), 195–199. https://doi.org/10.1111/j.1834-7819.2006.tb00427.x

Vorster L, Naidoo S, Stauf N, Holmgren C, Benzian H (2018). Fluoride content of toothpastes available in South Africa. *Community Dent Health*, **35**(3): 186–192. https://doi.org/10.1922/CDH_4294Vorster07

Appendix 1

The list of adult toothpastes by brands

ID	Brand	ID	Brand
1	Air-Lift Toothpaste	33	Jaris Natural Whitening Toothpaste Miswak
2	Amway Glister Multi-Action Fluoride Toothpaste	34	L'angelica Toothpaste for Sensitive Teeth with Ginseng and Goji Berry
3	Angola Extra Fresh toothpaste	35	Laser 3 Colour Toothpaste
4	AP24 Whitening Fluoride Toothpaste	36	Li-Zey White Boom LED Whitening Toothpaste
5	Arm & Hammer Advance White Toothpaste	37	Medicam Dental Cream
6	Atomy Toothpaste	38	Melaleuca Whitening Tooth Polish Paste with Fluoride
7	Bamboo Salt toothpaste	39	Morning Kiss Fluoride Toothpaste (Tea Tree Oil)
8	Beyond® Pearl White Whitening Toothpaste Advanced Formula	40	Neem Active Toothpaste
9	BlanCo Fresh & Natural Fluoride Toothpaste	41	Oradex Periodontal Vitamin Toothpaste
10	Ciptadent Maxi 12 Pus Toothpaste	42	Oral 7 Moisturising Toothpaste
11	Closeup Ever Fresh Toothpaste	43	Oral-B Tooth and Gum Care Fresh Mint Flavor Toothpaste
12	Colgate® Maximum Cavity Protection	44	Parodontax Daily Fluoride Toothpaste
13	Colgate® Optic White® Toothpaste	45	Patanjali Dant Kanti Medicated Oral Gel
14	Crescent Anti-Cavity Fresh Mint Toothpaste	46	Patanjali Dant Kanti Natural Toothpaste
15	Crest 3D White Brilliance Fluoride Anticavity Toothpaste	47	Pearlie White Advanced Whitening Fluoride Toothpaste
16	Curaprox Enzycal 1450 ppm toothpaste	48	Pearls Drop Extra Whitening Smokers Toothpaste
17	Darlie All Shiny White Supreme Toothpaste	49	Pepsodent© Cavity Fighter Toothpaste
18	Darlie Double Action Toothpaste	50	Pierrot Whitening 2in1 Toothpaste
19	Dentobac Neem Toothpaste	51	Pro Dental B Fresh Mint Toothpaste with Fluoride
20	DentYucral D Toothpaste	52	Pyodontyl Plus F Toothpaste
21	Dr Rashel Charcoal Whitening Toothpaste	53	Rapid White Daily Whitening Toothpaste
22	Econsave Choice Fluoridated Toothpaste	54	Safi Ubat Gigi Mikro Kalsium Dengan Kayu Sugi & Habbatus Sauda
23	Fluocaril Gum Care Toothpaste	55	Sayuti Kayu Sugi Toothpaste
24	Fluoride Toothpaste	56	Sensodyne® Repair and Protect Toothpaste
25	Follow Me Extra Cool Toothpaste	57	Signal Toothpaste Cavity Fighter
26	Formula Sparkling White Toothpaste	58	Siwak.F Toothpaste
27	Fresh & White Triple Cavity Protection Toothpaste	59	Sparkle Toothpaste
28	Genesis ProGum Care	60	Sunstar Ora 2 Stain Clear Toothpaste
29	Giant Cool Mint Toothpaste	61	T-Care Sensitive Toothpaste
30	Gum® Paroex Daily Prevention Toothpaste	62	Tesco Choice Freshmint Toothpaste
31	Himalaya Complete Care Toothpaste	63	Tesco Everyday Value Toothpaste
32	Jaris Natural Mineral Toothpaste - Dead Sea Salt	64	TheraBreath Fresh Breath Toothpaste

(*Continued on next page*)

Appendix 1 (*Continued*)

ID	Brand	ID	Brand
65	Wakamoto Avantbise Toothpaste	97	Grants Mild Mint with Aloe Vera Toothpaste
66	Watsons Freshmint Toothpaste	98	GreenZhi ToothGel
67	White Glo Extra Strength Whitening Toothpaste	99	Halagel Miswakgel Toothpaste
68	Winz Fluoride Toothpaste	100	Halagel With Neem and Clove Oil
69	Xerostom With Saliactive Toothpaste	101	HPA Herbal Toothpaste
70	Yaqeen Betel Leaf and Propolis Toothpaste	102^	K.P. Namboodiri's Ayurvedic Tooth Care Powder
71	Zact Whitening Toothpaste	103	K.P.Namboodiri's Ayurvedic Gel Toothpaste
72	Alive Natural Propolis Toothpaste	104	Leroselle Innovative Natural Toothpaste
73	All white Smokers' Toothpaste	105	Litna Herbal Toothpaste
74	Amboinense Toothpaste	106	LMZ Herbal Gum Specialist Toothpaste
75	As Shifa Herbal Toothpaste	107	Logodent Daily Care Organic Peppermint Toothpaste
76	Benfite toothpaste	108	Manuka Honey & Propolis Toothpaste with Manuka Oil
77	Bioaqua Herbal Mint Fresh Toothpaste	109	Manuka Vantage Toothpaste
78	Biorepair® Plus Total Protection Toothpaste	110	Marine Essence Toothpaste
79	BMS Organics Aloe Vera Toothpaste	111	Marvis Cinnamon Mint Toothpaste
80^	Charcoal Toothpaste Powder	112	Mericle 2 Action Whitening Toothpaste
81	Ciqlo Toothpaste Dr Rodzi Advance Formula	113	Miswak Herbal Toothpaste
82^	Clobas Tooth Powder	114	Mu'min B'Sugi
83	Coolwhite Toothpaste	115	Mu'min Premium Toothpaste – Extra Natural Mint
84	Coslys Toothpaste Gel for Sensitive Teeth and Gums	116	Najwa Toothpaste
85	Dabur Herb'l Natural Toothpaste Neem for Gum Care	117	Natura House Herbal Extra Sensitive Toothpaste
86	Dabur Red Toothpaste	118	Natural Activated Organic Bamboo Charcoal Toothpaste
87	Dentamate Herbal Toothpaste	119	Nazif Toothpaste
88	Denticare Toothpaste	120	NueVco Extra Virgin Coconut Oil Brightening Toothpaste
89	Dentiste' Night Time Toothpaste	121	Oral Care Whitening Toothpaste
90	Dentobac Cool AXN Whitening Herbal Striped Toothpaste	122	Orifera Natural Virgin Coconut Oil Toothpaste
91	Dentobac Gel Natural Herbal Toothpaste	123	Oxyfresh Toothpaste
92	D dōTERRA On Guard® Natural WhiteningToothpaste	124	Propolise Oral Care Stain Removal Teeth Cleaning Dental Cream Toothpaste
93	Dr. Neem Herbal Toothpaste	125	Pureen Maternity Toothpaste
94	DXN Ganozhi Toothpaste	126	Raiya Go Fresher Non Fluoride Toothpaste
95	Forever Living Bright Tooth gel	127	Rasyan Herbal Clove Toothpaste
96	Gano Fresh Toothpaste with Ganoderma Lucidum Extract	128	Red Seal Propolis Natural Oral Protection

(*Continued on next page*)

Appendix 1 (*Continued*)

ID	Brand	ID	Brand
129	Roselle Toothpaste	137^	Turbo Carbon Super Polish Teeth Whitening
130	Roselle Toothpaste Collagen	138	Vibrant Bright Toothpaste
131	Shabondama Toothpaste	139	Vicco Herbal Toothpaste
132	Splat Special Whitening Toothpaste Gold	140^	Vicco Vajradanti Pure Herbal Tooth Powder
133	Taybah Toothpaste	141	Xylin Gamat Toothpaste
134	Tinnergy Toothpaste Olive Oil	142	Xylin Specialist Toothpaste
135	TruCare Nano Silver Toothpaste	143	XyliWhite Refreshmint Toothpaste Gel
136	Turbo Carbon Activated Charcoal Toothpaste	144	Young Living- Thieves Aroma Bright Toothpaste

Note: ^Powder-based product; ID 1 to 71 is indicated for fluoridated toothpaste; ID 71 to 144 is indicated for non-fluoridated toothpaste.