

“Copycat-policosanols” *versus* genuine policosanol

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RESUMEN. El policosanol es una sustancia hipocolesterolémica y antiagregante plaquetaria, que consiste en una mezcla de ocho alcoholes alifáticos primarios superiores, purificada de la cera de la caña de azúcar (*Saccharum officinarum*, L.). La composición relativa y el contenido total de dichos alcoholes definen la identidad y pureza del policosanol, respectivamente, constituyendo las especificaciones de calidad más relevantes para la aprobación de un lote de ingrediente activo o de tabletas. La eficacia, seguridad y tolerabilidad del policosanol han sido ampliamente estudiadas utilizando productos que responden a los criterios de calidad establecidos. Recientemente, sin embargo, han aparecido en varios mercados diferentes mezclas de alcoholes llamadas “policosanoles”, cuyas promociones se basan en evidencias obtenidas con el policosanol original, aunque se conoce que mezclas diferentes de dichos alcoholes inducen respuestas biológicas diferentes. El presente trabajo compara la composición del policosanol genuino con las de varios “policosanoles-copias”: tres ingredientes activos y 25 formas terminadas, para lo cual se emplearon los métodos de análisis por Cromatografía de Gases validados y utilizados en el control de calidad del policosanol. Ninguno de los tres ingredientes activos referidos cumplieron con los criterios de identidad y pureza del policosanol, radicando las mayores discrepancias en la identidad, al presentarse cuatro de los alcoholes fuera de las especificaciones y estar algunos ausentes. Evidentes discrepancias fueron también encontradas en los productos terminados, de los cuales sólo seis cumplieron con el contenido de alcoholes declarado y muchos presentaron desviaciones burdas. En ningún caso se alcanzaron los criterios de identidad, además, varios alcoholes se encontraron fuera de las especificaciones y algunos completamente ausentes. Así, las diferencias encontradas con el policosanol genuino fueron más que las equivalencias, tanto para los ingredientes activos como para las formas terminadas, lo que lleva a esperar diferencias en sus efectos. Los policosanoles-copia, por tanto, merecen investigaciones independientes que demuestren su eficacia y seguridad, en lugar de promover reivindicaciones sin resultados que las avalen.

ABSTRACT. Policosanol is a cholesterol-lowering and antiplatelet substance consisting of a mixture of eighth higher aliphatic primary alcohols purified from sugarcane (*Saccharum officinarum*, L.) wax, whose relative composition supports its identity, and their total content the purity of the active ingredient. Policosanol identity and purity are reproducible, being the most outstanding quality specifications for the batch approval of the active ingredient or tablets. The efficacy, safety, and tolerability of policosanol have been extensively studied, the substance and drug products used in these studies responding to the quality specifications established. Recently, however, different mixtures of aliphatic alcohols, referred as “policosanols,” are in several markets, referring their claims to the evidences obtained with the original policosanol. Nevertheless, previous data support that different mixtures of such alcohols induce different biological responses. Then, here are compared the compositions of some “copycat-policosanol”: three active ingredients and 25 drug products, with that of genuine policosanol. Samples were processed according to the validated Gas Chromatographic methods used in the quality control of policosanol. None of the three active ingredients met policosanol identity and purity, the most striking discrepancy being referred to the identity, since the relative proportions of at least four alcohols were out of specifications

(OOS), and some alcohols absent. Evident discrepancies were also found in the finished products, since only six complied with declared content of alcohols, many deviations being gross. No case reached the identity criterion, several alcohols being OOS, and some altogether missing. Differences rather than equivalence were detected after the analyses of both active ingredients and finished forms containing copycat-policosanols, leading to expected differences in their effects. Thus, copycat-policosanols deserve independent research to demonstrate their efficacy and safety, instead of formulating claims without supportive data.

INTRODUCTION

Biological activities of higher aliphatic primary alcohols has been a subject of research for many years. Early works were mainly focused on anti-inflammatory effects of 1-triacontanol (C_{30})¹ and ergogenic and neurological effects of 1-octacosanol (C_{28}),^{2,3} isolated from beeswax and germ oils, respectively. On the other hand, it was reported that the addition of sugar cane wax to the diet lowered the levels of plasma lipids in rats, but the authors did not attribute the effect to the long-chain alcohols fraction.⁴ Later on, when effects of 1-octacosanol on lipid metabolism were investigated in mice, a reduction of hepatic lipid, mainly triglycerides, was observed.⁵

None of these studies referred to the tested substances as policosanol. It was only from the '90s that a spate of results appeared documenting the cholesterol-lowering, antiplatelet and antioxidant effects of a substance named policosanol.⁶⁻³⁸ This is a mixture of eighth higher aliphatic

primary alcohols purified from the wax of sugar cane (*S. officinarum*), namely: 1-tetracosanol (C_{24}) (0.01-2 %), 1-hexacosanol (C_{26}) (3.0-10 %), 1-heptacosanol (C_{27}) (0.1-3.0 %), 1-octacosanol (C_{28}) (60-70 %), 1-nonacosanol (C_{29}) (0.1-2 %), 1-triacontanol (C_{30}) (10-15 %), 1-dotriacontanol (C_{32}) (5-10.0 %), and 1-tetracontanol (C_{34}) (0.1-5 %).⁸ The relative abundance of each alcohol define the identity of this substance; and its purity, expressed as content of the standard mixture must be ≥ 90 % for batch acceptance. Gas chromatographic (GC) methods were developed and validated to identify and quantify higher aliphatic alcohols in both active ingredient and finished products.^{39,40}

Policosanol inhibits cholesterol biosynthesis⁴¹⁻⁴⁴ also increasing the low-density lipoprotein (LDL)-receptor dependent processing.^{42,44} The efficacy, safety and tolerability of policosanol have been established in clinical studies on healthy volunteers,¹⁹ on patients with type II Hypercholesterolemia (HC)¹¹⁻²⁹ or with dyslipidemia due to type 2 diabetes mellitus.³⁰⁻³³ It also increase walking distances in patients with intermittent claudication,⁴⁵⁻⁴⁸ inhibit platelet aggregation and protect LDL from lipid peroxidation.⁸⁻³⁸ Long-term post-marketing surveillance studies have corroborated the excellent tolerability of the treatment.⁴⁹⁻⁵¹

In the last years, however, different mixtures of aliphatic alcohols, referred to as policosanols, have been introduced in several markets with appended claims of efficacy and tolerability that merely refer to studies conducted on the original policosanol,⁹⁻⁵¹ without the support of independent data. Until such evidence is provided, it must be acknowledged that genuine policosanol is the only product on the market with proven efficacy, safety and tolerability.

The concept of policosanol has been simplified as a mixture of higher aliphatic primary alcohols,⁵² disregarding the identity and without proofs documenting the efficacy and safety of variable compositions, contributing to the confusion about what is actually policosanol. In this context it must be stressed that mixtures of higher aliphatic alcohols from different sources, having different compositions and degrees of purity can induce different biological responses, as previously reported.^{53,54}

The most convincing evidence of that comes from D-002, a substance

also referred under the acronym BWA (beeswax alcohols), containing the following mixture of higher aliphatic alcohols purified from beeswax (*Apis mellifera*): C_{24} (8-15 %), C_{26} (7-20 %), C_{28} (12-20 %), C_{30} (25-35 %), C_{32} (18-25 %), and C_{34} (≤ 7.5 %), with an overall purity = 85 %.⁵⁵ A comparison of policosanol and BWA, with quite similar manufacturing processes, shows that their compositions depend on the nature of the source material. While C_{28} is the most abundant long-chain alcohol in policosanol,⁸ C_{30} , the most abundant one in BWA, only represents 25 to 35 % of such active ingredient.⁵⁶ Furthermore, experimental evidence showed that, although some common actions were found, these substances diverged widely with regards to the most important effect. Thus, BWA did not show appreciable lipid-lowering effect.^{55,56} Likewise, policosanol^{8,32-36} inhibited platelet aggregation while BWA did not,^{55,56} the opposite being true for the anti-inflammatory activity.^{56,57} In addition, the experimental effects common for the two products, like the inhibition of ulcers induced with ethanol or aspirin, show different pharmacological potencies and efficacy.⁵⁸⁻⁶⁰ On the other hand, although both policosanol and BWA inhibit LDL-lipid peroxidation, the effective doses of policosanol (5-10 mg/d) are lower than that of BWA (50 mg/d).^{37,38, 60-62}

Therefore, the effects of different mixtures of high molecular weight alcohols can be different. This point was brought out by a clinical study that compared the effects of genuine policosanol with a copycat policosanol named Octa-60, from Garuda International, allegedly isolated from sugar cane wax.⁶³ The study showed not only that genuine policosanol (5 and 10 mg/d) was superior to Octa-60 (5 and 10 mg/d) for reducing LDL-C, TC and atherogenic ratios, and to raise HDL-C, but that Octa 60 did not reach the efficacy criterion of lowering LDL-C. The percent of randomized patients reaching LDL-C goals was significantly greater with the former; HDL-C increased with both doses of policosanol, not with Octa-60. Although both preparations were well tolerated, policosanol was better tolerated than Octa-60.⁶³ A paper researched the effects of a "policosanol" from wheat germ, obtained also from Garuda International, reported that such "policosanol" failed to lower plasma cholesterol.⁶⁴ The reported composition of the wheat germ

"policosanol" did not reproduce that of genuine policosanol and also it was administered incorporated in chocolate pellets, a way not explored previously.

This background evidences that before assume the equivalence of the effects of different mixtures of higher alcohols based on the data obtained with one of them, it is mandatory to generate own data supporting efficacy, safety and tolerability, and how important is to adequately test quality specifications. It will be the best, in principle, for the patient health. To broaden the view on this controversial subject, in the current paper the compositions of three "copycat-policosanol" drug substances (active ingredients) and of 25 "copycat-policosanol" drug products available on different markets are compared with that of genuine policosanol; which is, up to date, the only one with efficacy and safety supported by many studies.

MATERIALS AND METHODS

Chemicals

All chemicals were of analytical reagent grade. Standards of reference of the alcohols C_{24} , C_{26} , C_{27} , C_{28} , C_{30} Internal Standard alcohol C_{20} and *N*-methyl, *N*-trimethylsilyl trifluoroacetamide (MSTFA) were obtained from Sigma (USA) and chloroform from Merck (Germany).

Copycat-policosanol samples were provided by Laboratorios Dalmer S. A.: Octa 60, batch 860-01120FF and batch 863-01148FF, Lesstanol, Garuda, USA; Octa 95, batch 706-99235EM, Lesstanol, Garuda, USA; Cholesterol Balance Radiance, batch 04; Polik 5 mg, UNIPHARM SA, Guatemala, batch U E 03/06; Esterol Plus, Laborest, Italy, batch 020552; Feminesse, Persue Corp., South Africa, batch 4787; Normolip 5 Esi, Italy, batch E274 D; Cosanol, Generis, El Salvador, batch 30102; PP- 5, Cubarbs, Dominican Republic, batch 8023482; J & B, Australia, batch 43677; Policosanol tablets, Panacea Biotec Ltd. India, batch PLS-06; Arterol V12, NATURE'S CARE Australia, batch 1247B and batch 1180A/1; Polik 10 mg, UNIPHARM SA, Guatemala, batch TU E 03/06; Armo Lipid, Rotthapharm, Italy, no batch declared, Maxi-cosanol, Bioglan, Australia, batch 35199E; Nuvita, Dominican Republic, batch 5345; One a Day, Bayer, USA, batch 5DA0865; PPG-Optim, Mexico, batch 04101; Cholesterex 10, South Africa, batch 4786; Cholesterol Formula CVS,

USA, no batch declared; Cholesterol Health, Royal Nutrition Internat., batch 8022-13; Cholestin, PHARMANEX, batch CS28811; Energe Activator-Lion Sciences, batch 20005225; Liponil Forte, South Africa, batch G57505; Polik, Guatemala, batch 02 TN 11-07-03; Nature's Life, USA, batch 313033.

Equipment

A Gas Chromatograph GC-14B (Shimadzu, Japan) with flame ionization detector, equipped with a BPX-5 capillary column (0.53 mm I.D. X 25 m) was used for chromatographic analyses. Carrier gas flow was 11 mL/min and injection volume was 1 μ L. The oven was heated from 230 to 320 °C at 10 °C/min and finally kept for 10 min at the highest temperature; injector and detector were heated at 320 °C.

Test procedure

Analysed samples were processed according to validated analytical methods.^{39,40} Twenty tablets or capsules were randomly selected and weighed, their net average mass was determined, and then the material was crushed to a fine powder. A weight equivalent to that of one tablet/capsule (20 mg in case of active ingredient) was quantitatively transferred to a 10 mL test tube provided with a screw cap; 3 mL of internal standard (0.4 mg 1-eicosanol/mL in chloroform) were added and the capped tube was heated at 60 °C for 10 min with occasional shaking. The hot solution was then filtered (Whatman No. 1, filter paper, Maidstone, UK) and 0.5 mL of the filtrate was transferred to another tube.

MSTFA (0.05 mL) was added, the capped tube was heated for 15 min at 60 °C, and finally 1 μ L portions were examined by GC.

RESULTS AND DISCUSSION

Three batches of copycat active ingredients referred to as "policosanols", whose brand names were Lesstanol Octa-60 and Lesstanol Octa-95 were analyzed (Table 1). It can be seen that such substances did not fulfill the quality specifications of genuine policosanols.

In the first place, neither substance met the criterion for batch purity, referred to the total content of the eight high molecular weight alcohols. Second, the most striking discrepancies were those referred to the identity of the analyzed batches of active ingredients, whose relative proportions of the individual alcohols did not meet specification ranges of genuine policosanols. Thus, in two batches of Lestannol Octa-60, C_{24} , C_{28} , and C_{32} were out of specifications (OOS), while OOS values for C_{30} were found in only one batch, a witness of the poor reproducibility from batch to batch. In turn, all individual alcohols of the batch of Lestannol Octa-95 were OOS and two of them (C_{24} and C_{29}) were absent. The authors could therefore conclude that the active ingredients under study were different, not equivalent to policosanols, although all they consisted of mixtures of higher alcohols allegedly obtained from sugar cane wax.

Evident discrepancies were also found in the finished products. In the first place, only six analysed products Polik 5 and 10 mg (Guat-

mala), Feminesse (South Africa), ArmoLipid (Italy), Nature's Life and Cholesterol Formula (USA) were found to comply with international pharmaceutical rules, requiring that actual content falls between 92.5 and 107.5 % of declared content; while the remaining products were OOS in terms of content, 17 being below 90 % of the declared content (Table 2). This finding could point to two different technical errors: 1) the use of a fixed formula for manufacturing the finished forms, not compensating the differences of the total content of high molecular weight alcohols (purity) of the respective active ingredients; 2) inadequate analytical methods. In any case, however, a poor quality control on the manufacturing of these forms is evident.

In 11 analyzed products the deviations were gross, representing less than 80 % of the declared contents. An enormous difference (26 %) was observed between two batches of the same product, Arterol V 12 (Australia), whose contents were 58.5 and 84.5 %.

Secondly, the identities of the mixtures of alcohols were different from that specified for policosanols, as already observed in the case of active ingredients, several of the constituent alcohols were OOS, and some were altogether missing (Tables 3 and 4). Thus, even for those products that complied with the declared content of total alcohols, the relative proportions of several individual alcohols were OOS. As an example it can be seen that in the case of Polik 5 and 10 mg, analyses revealed that four out of eight individual alcohols were OOS, so that

Table 1. Results of analyses of copycat-policosanols active ingredient (n = 3) and ranges defining policosanols identity and purity.

Individual alcohols	Relative composition			
	Policosanols (%)	Lesstanol (Garuda, SA)		
		Octa- 60 Batch 860-01120FF	Octa- 60 Batch 863-01148FF	Octa- 95 Batch 706-99235EM
1-tetracosanol (C_{24})	0.01 - 2	2.76 ^a	4.23 ^a	0.00 ^a
1-hexacosanol (C_{26})	3.0 - 10	5.92	6.30	0.33 ^a
1-heptacosanol (C_{27})	0.1 - 3.0	0.15	0.19	0.09 ^a
1-octacosanol (C_{28})	60 - 70	56.18 ^a	45.36 ^a	82.18 ^a
1-nonacosanol (C_{29})	0.1 - 2	0.23	0.20	0.00 ^a
1-triacontanol (C_{30})	10 - 15	8.14 ^a	11.64	2.15 ^a
1-dotriacontanol (C_{32})	5 - 10.0	3.90 ^a	4.03 ^a	0.50 ^a
1-tetratriacontanol (C_{34})	0.1 - 5	4.20	4.11	0.17 ^a
Purity	≥ 90	81.48 ^a	76.06 ^a	85.32 ^a

n Number of analysis for each sample. ^a Out of specifications.

Table 2. Total higher aliphatic alcohols content of 25 copycat-policosanols products (n = 3).

Commercial name	Batch	Content (mg)		Declared content (%)
		Declared	Found (n = 3)	
Cholesterol Balance Radiance	04	3.3 ^{a,b}	2.00	60.6 ^d
Polik 5 mg, UNIPHARM SA, Guatemala	TU E 03/06	5	4.87	97.4
Esterol Plus, Laborest, Italy	020552	5	5.86	117.2 ^d
Feminesse, Persue Corp., South Africa	4787	5	5.01	100.2
Normolip 5 Esi, Italy	E274 D	5	3.80	76.0 ^d
Cosanol, Generis, El Salvador	30102	5	4.23	84.6 ^d
PP- 5, Cubarbs, Dominican Republic	8023482	5	3.82	76.4 ^d
J & B, Australia	43677	5	3.51	70.2 ^d
Policosanols tablets, Panacea Biotec Ltd. India	PLS-06	5	3.00	60.0 ^d
Arterol V12, NATURE'S CARE Australia	1247B	6 ^{a,c}	5.07 ^c	84.5 ^{c,d}
Arterol V12, NATURE'S CARE Australia	1180A/1	6 ^{a,c}	3.51 ^c	58.5 ^{c,d}
Polik 10 mg, UNIPHARM SA, Guatemala	TU E 03/06	10	9.52	95.2
Armo Lipid, Rotthapharm, Italy	—	10	10.16	101.6
Maxi-cosanol, Bioglan, Australia	35199E	10	5.17	51.7 ^d
Nuvita, Dominican Republic	5345	10	0.18	1.8 ^d
One a Day, Bayer, USA	5DA0865	10	8.43	84.3 ^d
PPG-Optim, Mexico	04101	10	0.00	0.0 ^d
Cholesterex 10, South Africa	4786	10	9.17	91.7 ^d
Cholesterol Formula CVS, USA	—	10	10.29	102.9
Cholesterol Health, Royal Nutrition Internat.	8022-13	10	0.39	3.9 ^d
Cholestin, PHARMANEX	CS28811	15 ^a	12.52	83.5 ^d
Energe Activator-Lion Sciences	20005225	15 ^a	9.83	65.5 ^d
Liponil Forte, South Africa	G57505	20	17.28	86.4 ^d
Polik, Guatemala	02 TN 11-07-03	20	3.22	1.6 ^d
Nature's Life, USA	313033	23 ^a	23.15	100.6

^a There are no tablets of genuine policosanols with these strengths. ^b Strength below effective range. ^c See batch to batch variability.

^d Out of specifications (content must be between 92.5 and 107.5 % of the average declared content as per European guidelines).

n Number of analysis for each sample.

the mixture of higher alcohols contained in these tablets cannot be considered as equivalent to the clinically tested genuine policosanols. Likewise, Armo Lipid and Cholesterol Formula contain four alcohols OOS, and its high contents of 1-hexacosanol leads to suspect that their origin is other than sugarcane wax.

It must be noted that the relative abundance of 1-octacosanol, the major component of genuine policosanols, only reach the expected amount in six of the finished products, while in most cases the relative abundance of the other alcohols did not fall within the limits of policosanols identity. In some cases, as Cholestin from Pharmanex, 1-triacontanol was the most abundant component, as expected from a mixture of alcohols obtained from beeswax, while 1-dotriacontanol was the most abundant one in Energe acti-

vator tablets from Lion Sciences. These differences, besides disproving equivalence with genuine policosanols, also indicate that such mixtures were obtained from sources other than sugar cane wax. A separate mention deserves the case of PPG-Optim (Mexico), a product containing no fatty alcohol.

Manufacturers using the name "policosanols" for their products clearly aim to take advantage of published researches carried out with the original policosanols instead of investing time and resources for demonstrating efficacy, safety and tolerability of their mixtures. These products, as shown in the current study, are false relatives of genuine policosanols. The marketing of such copycat-policosanols not only infringes intellectual property rights, but, even worse, practices a deceit on patients. The magnitude of the problem becomes apparent on reviewing

the numerous Web pages publicizing fake policosanols.

CONCLUSIONS

Policosanols is not a simple word covering any mixture of high molecular weight alcohols. Analyses of several copycat policosanols as both active ingredients and finished forms showed relevant deviations from the identity of genuine policosanols. None of the three active ingredients met policosanols identity and purity, the most striking discrepancy being referred to the identity, since the relative proportions of at least four alcohols were out of specifications (OOS), and some alcohols absent. Evident discrepancies were also found in the finished products, since only six complied with declared content of alcohols, many deviations being gross. No case reached the identity criterion, several alcohols being OOS, and

Table 3. Analytical profiles of copycat-policosanols (n = 3) with the same declared strengths that genuine policosanols tablets.

Commercial name	Batch	Found content (mg)							
		C ₂₄	C ₂₆	C ₂₇	C ₂₈	C ₂₉	C ₃₀	C ₃₂	C ₃₄
Comparison with policosanols 5 mg tablets									
Estimated ranges per alcohol in the tablet		0.001 - 0.15	0.14 - 0.43	0.005 - 0.16	2.78 - 3.77	0.005 - 1.11	0.46 - 0.81	0.23 - 0.54	0.005 - 0.538
Polik 5 mg, UNIPHARM SA, Guatemala	TU E 03/06	0.03	0.85 ^a	0.05	<u>2.63</u> ^a	0.10	1.16 ^a	0.00 ^a	0.01
Esterol Plus, Laborest, Italy	020552	0.00 ^a	0.01 ^a	0.00 ^a	<u>3.71</u>	0.00 ^a	1.70 ^a	0.31	0.23
Feminesse, Persue Corp., South Africa	4787	0.06	0.25	0.08	<u>3.15</u>	0.1	0.9 ^a	0.34	0.14
Normolip 5 Esi, Italy	E274 D	0.01	0.00 ^a	0.00 ^a	<u>2.96</u>	0.00 ^a	0.00 ^a	0.00 ^a	0.00 ^a
Cosanol, Generis, El Salvador	30102	0.14	0.35	0.01	<u>2.68</u> ^a	0.02	0.60	0.24	0.19
PP- 5, Cubarbs, Rep. Dominicana	8023482	0.07	0.37	0.01	1.01 ^a	0.05	<u>1.88</u> ^a	0.40	0.03
J & B, Australia	43677	0.06	0.46 ^a	0.00 ^a	<u>2.40</u> ^a	0.00 ^a	0.51	0.08 ^a	0.01
Policosanols Tablet, Panacea Biotec Ltd. India	PLS-06	0.02	0.08 ^a	0.30 ^a	<u>0.85</u> ^a	0.14	0.53	0.06 ^a	0.03
Comparison with policosanols 10 mg tablets									
Estimated ranges per alcohol in the tablet		0.002 - 0.30	0.28 - 0.86	0.010 - 0.32	5.56 - 7.54	0.010 - 0.22	0.92 - 1.62	0.46 - 1.08	0.010 - 1.07
Polik 10 mg, UNIPHARM SA, Guatemala	TU E 03/06	0.06	1.68 ^a	0.09	<u>5.12</u> ^a	0.21	2.28 ^a	0.07 ^a	0.00 ^a
Armo Lipid, Rotthapharm, Italy	02	0.12	1.66 ^a	0.10	<u>5.58</u>	0.21	2.46 ^a	0.05 ^a	0.00 ^a
Maxi-cosanol, Bioglan, Australia	35199E	0.08	0.12 ^a	0.00 ^a	<u>4.42</u> ^a	0.07	0.48 ^a	0.00 ^a	0.00 ^a
Nuvita, Dominican Republic	5345	0.00 ^a	0.00 ^a	0.00 ^a	0.00 ^a	0.00 ^a	<u>0.10</u> ^a	0.08 ^a	0.00 ^a
One a Day, Bayer, USA	5DA0865	0.00 ^a	0.55	0.06	<u>6.66</u>	ND	0.76	0.31	0.09
PPG-Optim, Mexico	04101	0.00 ^a	0.00 ^a	0.00 ^a	0.00 ^a	0.00 ^a	0.00 ^a	0.00 ^a	0.00 ^a
Cholesterex 10, South Africa	4786	0.16	0.47	0.03	<u>5.94</u>	0.06	1.64 ^a	0.59	0.28
Cholesterol Formula CVS, USA	-	0.52 ^a	<u>4.58</u> ^a	0.03	4.16 ^a	0.16	0.71	0.12 ^a	0.01
Cholesterol Health, Royal Nutrition Internat	8022-13	0.00 ^a	0.07 ^a	0.00 ^a	0.06 ^a	0.00 ^a	<u>0.10</u> ^a	<u>0.10</u> ^a	0.07
Comparison with policosanols 20 mg tablets									
Estimated ranges per alcohol in the tablet		0.004 - 0.60	0.56 - 1.72	0.02 - 0.64	11.12 - 15.08	0.02 - 0.44	1.84 - 3.24	0.92 - 2.16	0.02 - 2.14
Liponil Forte, South Africa	G57505	0.08	1.84 ^a	0.17	<u>11.03</u> ^a	0.40	3.47 ^a	0.22 ^a	0.07
Polik	02 TN 11-07-03	0.23	0.21 ^a	0.00 ^a	0.34 ^a	0.43	<u>0.92</u> ^a	0.90 ^a	0.20

n Number of analysis for each sample. Underlined Majority compound. ^a Out of specifications. ND Not determined.

some altogether missing. Thus, copycat-policosanols deserve an independent research to avoid the exposure of the consumer to low quality and lack of evidence products that cannot be assumed from those obtained with the genuine policosanols.

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Table 4. Analytical profiles of copycat-policosanol tablets (n = 3) with other declared strength, comparison with the estimated ranges per alcohol in hypothetical tablets containing such policosanol content.

Commercial name	Batch	Found content (mg)							
		C ₂₄	C ₂₆	C ₂₇	C ₂₈	C ₂₉	C ₃₀	C ₃₂	C ₃₄
Comparison with hypothetical policosanol 3.3 mg tablets									
Estimated ranges per alcohol in a tablet containing 3.36 mg policosanol ¹		0.001	0.092	0.003	1.835	0.003	0.304	0.152	0.003
		-0.099	-0.284	-0.106	-2.488	-0.733	-0.535	-0.356	-0.355
	04	0.20	0.20	0.00 ^a	0.53 ^a	0.00 ^a	<u>0.56^a</u>	0.39 ^a	0.10
Comparison with hypothetical policosanol 6 mg tablets									
Estimated ranges per alcohol in a tablet containing 6 mg policosanol ¹		0.001	0.168	0.006	3.34	0.006	0.552	0.276	0.006
		-0.18	-0.516	-0.192	-4.524	-1.332	-0.972	-0.648	-0.646
Arterol V12 NATURE'S CARE	1247B	0.22 ^a	0.58 ^a	0.08	<u>3.17^a</u>	0.07	0.91	0.03 ^a	0.01
Arterol V12 NATURE'S CARE	1180A/1	0.01	0.61 ^a	0.02	<u>3.08^a</u>	0.07	0.98	0.10 ^a	0.00 ^a
Comparison with hypothetical policosanol 15 mg tablets									
Estimated ranges per alcohol in a tablet containing 15 mg policosanol ¹		0.003	0.42	0.015	8.34	0.015	1.38	0.69	0.015
		-0.45	-1.29	-0.48	-11.31	-0.33	-2.43	-1.62	-1.05
Cholestin, PHARMANEX	CS28811	2.56 ^a	1.53 ^a	0.07	2.22 ^a	0.04	<u>4.10^a</u>	1.89 ^a	0.06
Energe Activator-Lion Sciences	20005225	0.02	0.07 ^a	0.03	0.50 ^a	0.03	1.31 ^a	<u>5.96^a</u>	1.91 ^a
Comparison with hypothetical policosanol 23 mg tablets									
Estimated ranges per alcohol in a tablet containing 23 mg policosanol ¹		0.005	0.644	0.023	12.788	0.023	2.116	1.058	0.023
		-0.69	-1.978	-0.736	-17.34	-0.506	-3.726	-2.484	-2.46
Nature's Life	313033	0.18	4.29 ^a	0.27	<u>12.05^a</u>	0.42	5.68 ^a	0.24 ^a	0.01 ^a

¹Estimation of the ranges for these tablets was proportionally based on the defined ranges of commercial policosanol tablets presented in Table 3. ²The recommended therapeutic range is from 5 to 20 mg/d, no evidence exists supporting the use of lower doses. Underlined Majority compound. ^a Out of specifications.

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