

Abstract

In this study 8 commercial roll-your-own (RYO) tobacco brands representing the 40% of this market in Spain have been smoked under ISO conditions, with and without catalyst. The mainstream smoke has been analyzed to study the main components of the gas and the particulate matter collected in the filters and in Cambridge filter pads (CFP). 3R4F tobacco has been also smoked for comparison.

The results show that RYO brands provide larger yields of nicotine, TPM and carbon monoxide than the 3R4F tobacco. The addition to the tobacco of materials of siliceous origin with a highly developed meso- and micro-porous structure has proven to be very in reducing the amount of almost all individual compounds analyzed, including carbon monoxide, nicotine and tar evolved when smoking such mixtures.

Introduction

The habits of tobacco consumption have changed in the last years, and the use of roll-your-own (RYO) cigarettes has increased noticeably, mainly due to their lower cost as compared to factory-made (FM) cigarettes. The erroneous belief that they are less hazardous [1] than FM cigarettes may also play an important role in this trend.

In a previous work [2] we analyzed the mainstream smoke from the 11 commercial top selling RYO tobacco brands in Spain, that was compared with 3R4F reference tobacco. The results obtained showed that the RYO brands studied deliver more nicotine and most of the products in the condensed fraction than the 3R4F reference tobacco, when smoked under the same conditions. Contrarily, the gas fraction produced is lower for these tobaccos than for the reference one, though no significant differences were observed in CO yields. It can be stated accordingly that RYO tobaccos are definitively not less hazardous than the reference tobacco, which may be contrary to popular belief.

In other works we studied the effect of different catalysts of the type of MCM-41 and SBA-15 on different tobaccos (citar), showing their effectiveness in reducing nicotine, tar, carbon monoxide and most of the compounds evolved in the tobacco smoking process.

In this work we present the results of the effect of the addition of a spherical SBA catalyst to eight RYO brands in the composition of the mainstream smoke. Additionally we have studied the effect of adding different catalysts to two of the more popular brands of RYO tobacco in Spain on the composition of the smoke generated.

Experimental

All materials catalysts were synthesized in our laboratory according to the literature[3-6]. Table 1 shows the catalysts properties and the reference describing the synthesis procedure.

Cigarettes were prepared by thoroughly mixing manually the tobacco with each powder material, using around 4 wt% of catalyst. After conditioned, they were smoked in a smoking machine [3-5], under the ISO 3308 [7] conditions using for all the emptied tubes of the 3R4F cigarettes. Yields of the condensable fraction were obtained by weight difference of the Cambridge filter pads before and after smoking and were analysed by GC/MS using a HP-5MS column, and named as TPM-T. The non-condensed products (gas fraction) were collected in a Tedlar bag and analysed by GC/TCD using CTR I column, and GC/FID using a GAS-PRO column [8].

Table 1. Textural parameters of the Catalysts

Properties	SBA Esf	SBA-15	Al-MCM-41	NaMCM-41
Pore Size (nm)	4.31	6.09	2.73	2.4
BET area (m ² /g)	879	757	1007	1036
Total Pore volume (cm ³ /g)	0.96	1.06	0.83	1.34
Si/Al ratio	----	----	119	0.37
Acidity (mmol/g)	0	0	0.3	0.02
Reference				

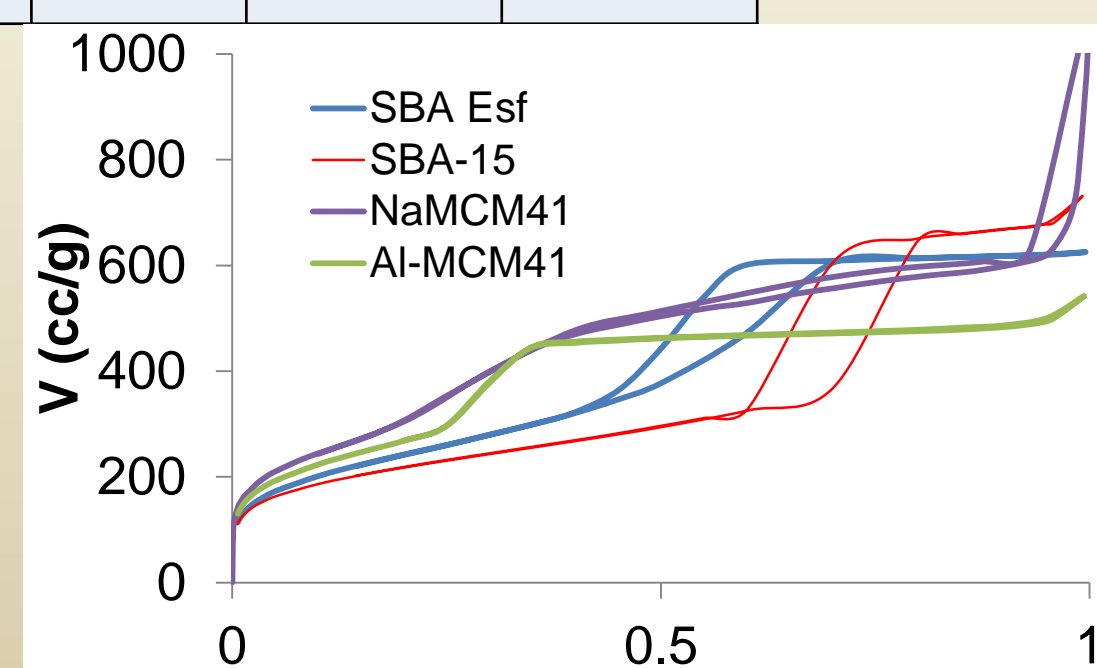
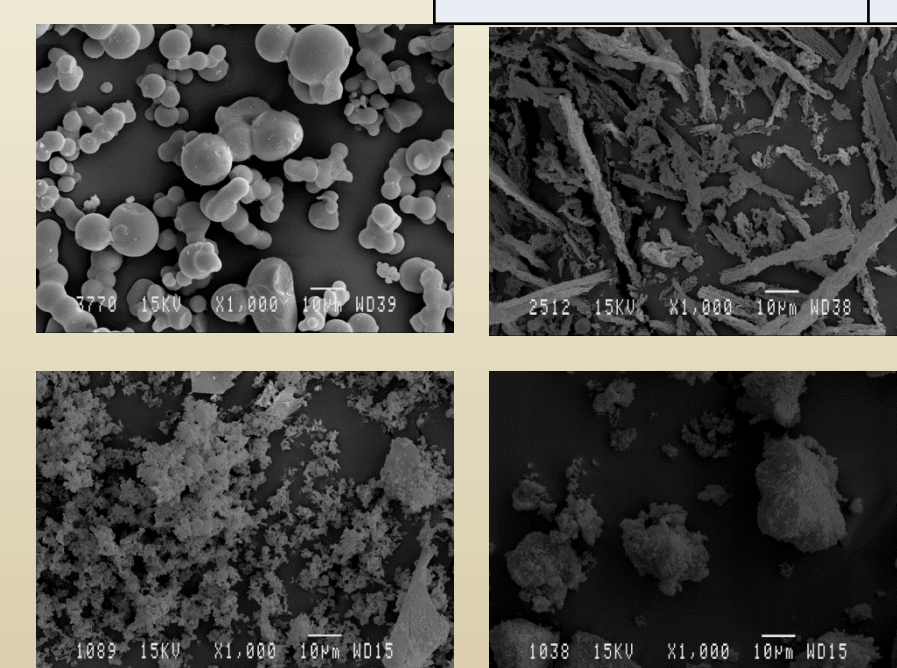


Figure 1. SEM Images of: SBA Esf, SBA-15, Al-MCM-41, NaMCM-41

Figure 2. Adsorption Isotherm of the catalyst

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Study of the effect of SBA Esf in the composition of the smoke

Table 2. Puff number, smoked tobacco amount, TPM-T, CO and reduction ratio for the different RYO tobaccos with catalyst SBA Esf.

	Puff number	Smoked tobacco amount (g)	TPM-T (mg/g smoked tobacco)	Nicotine (mg/g smoked tobacco)	CO (mg/g smoked tobacco)	REDUCTION TPM-T (%)	Reduction Nicotine (%)	Reduction CO (%)
Pueblo	10	7,66	19,38	2,039	18,644			
Pueblo+C	11	7,42	8,24	0,777	15,349	57,5	61,9	17,7
Golden Virginia	9	6,67	17,94	1,553	19,693			
Golden V.+C	10	6,71	12,26	1,093	19,700	31,7	29,6	0,0
Malboro	9,5	6,95	19,64	1,442	17,311			
Malboro+C	10	7,02	10,77	0,907	17,979	45,2	37,1	-3,9
Camel	10	7,64	19,12	1,329	19,427			
Camel+C	10	6,96	12,05	1,112	17,322	37,0	16,3	10,8
Chesterfield	9	7,09	18,77	1,183	19,876			
Chesterf+C	9	6,54	10,07	0,798	17,309	46,4	32,5	12,9
Winston	8,3	7,04	20,11	1,334	20,104			
Winston+C	9	6,48	11,07	0,961	17,154	45,0	28,0	14,7
Ducados Rubio	7,5	5,51	21,97	1,554	23,376			
Ducados R.+C	8	4,87	14,63	1,223	22,882	33,4	21,3	2,1
Cross Road	8,3	6,41	18,12	1,608	17,864			
Cross R.+C	8,5	6,47	15,85	1,175	20,089	12,5	27,0	-12,5

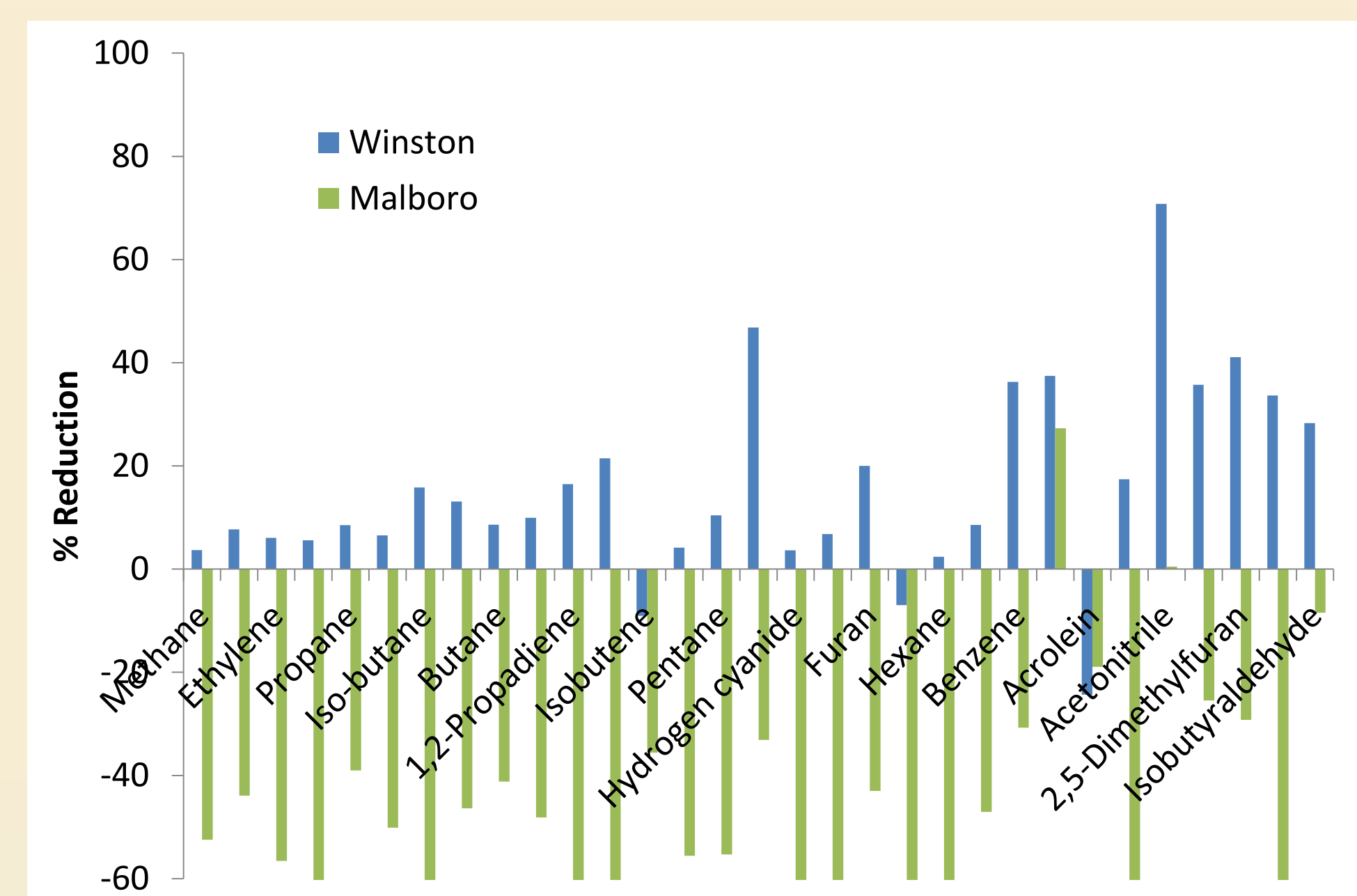


Figure 3. Reduction in gases obtained for the two RYO brands exhibiting the best and the poorest behavior with SAB Esf

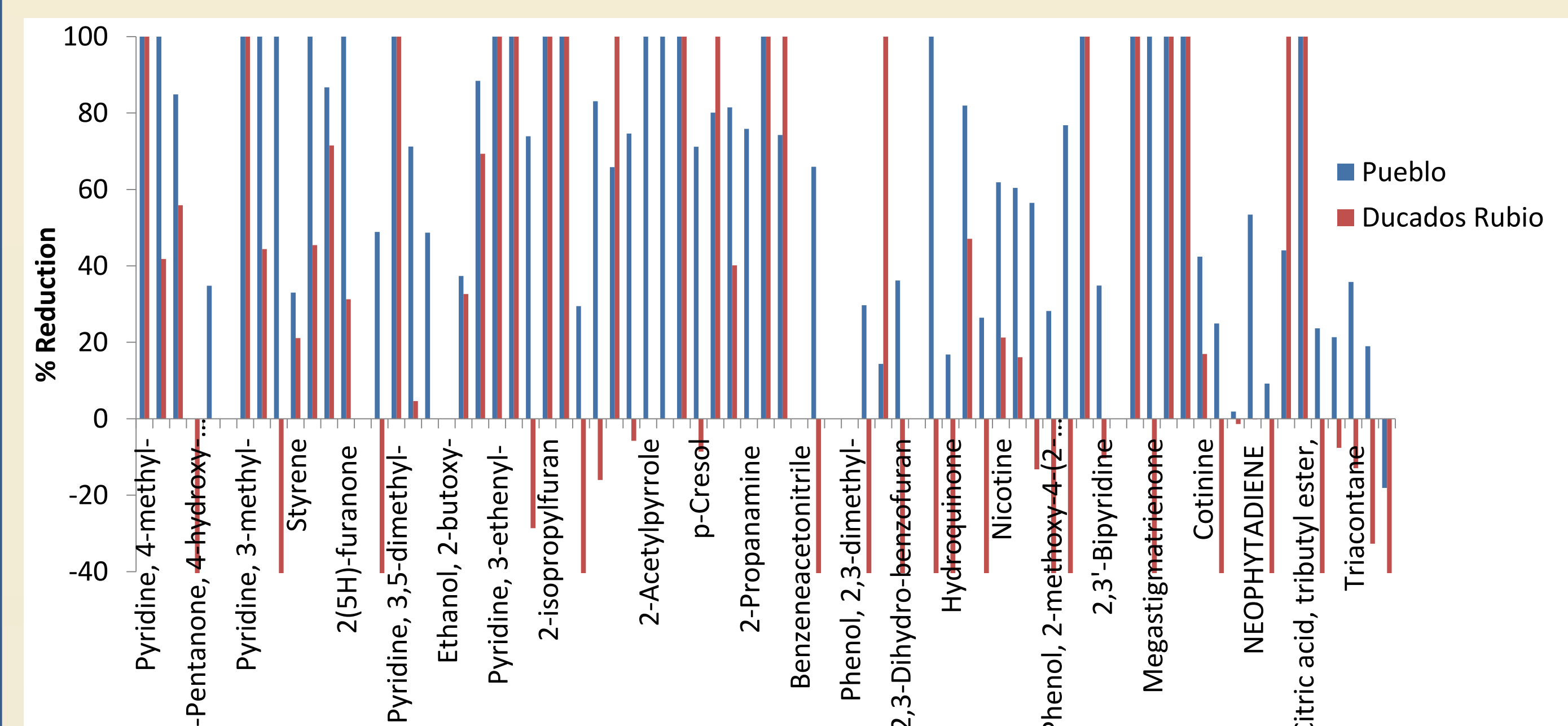


Figure 4. Reduction in TPM-T obtained for the two RYO brands exhibiting the best and the poorest behavior with SAB Esf

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Study of the effect of diferents catalysts

Table 3. Reduction in TPM-T, Nicotine and CO for the different RYO tobaccos

	REDUCTION TPM-T (%)	REDUCTION Nicotine (%)	REDUCTION CO (%)
Camel			
Camel+SBA Esf	37,0	16,3	10,8
Camel+SBA	56,1	62,4	17,3
Camel+NaMCM41	59,7	72,0	35,7
Camel+Al-MCM41	19,0	30,0	22,7
Winston			
Winston+SBA Esf	45,0	28,0	14,7
Winston+SBA	49,8	55,3	35,7
Winston+NaMCM41	75,5	83,0	33,5
Winston+Al-MCM41	40,5	52,0	31,4

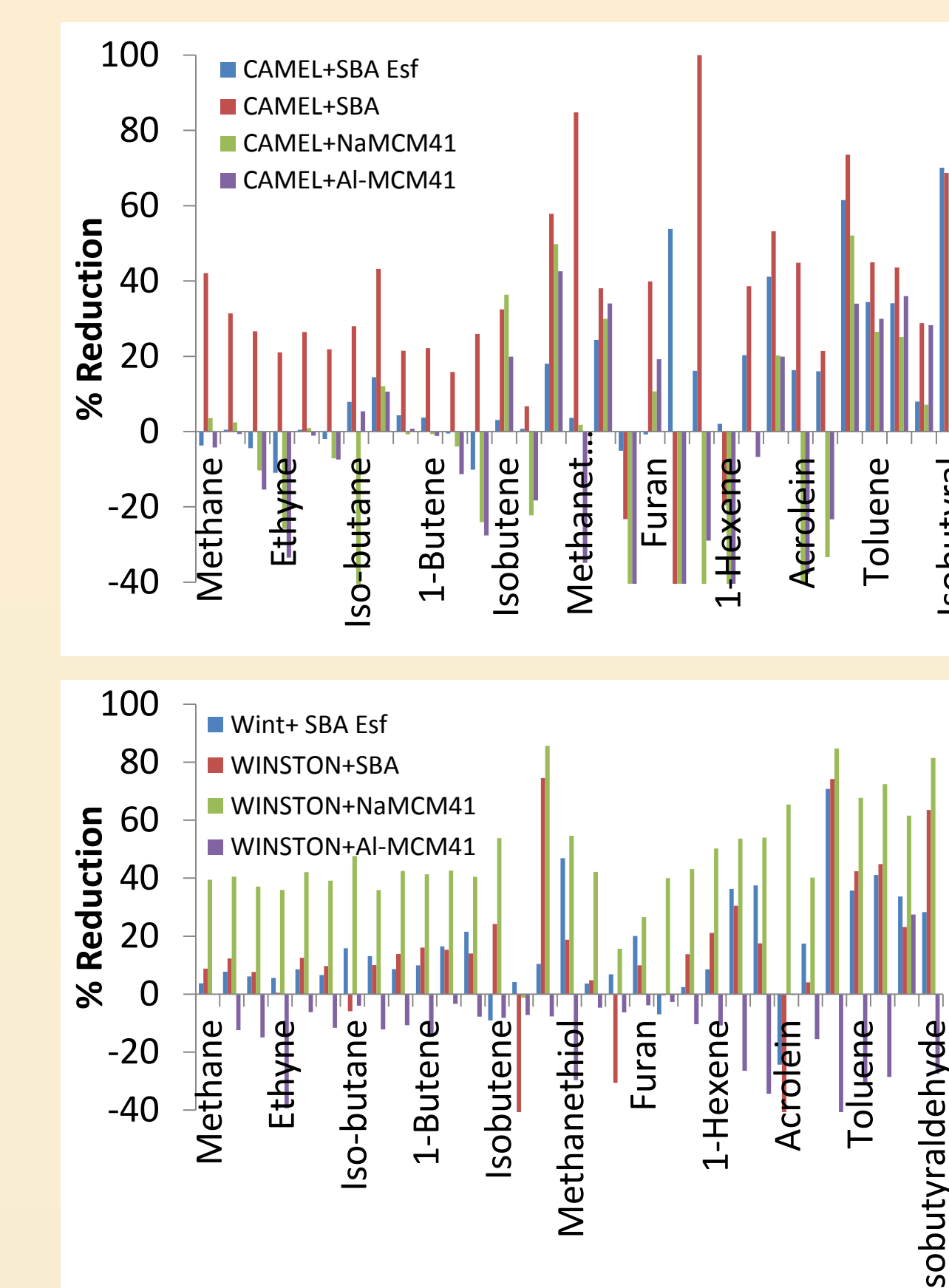


Figure 5. Reduction in gases obtained for RYO Winston and Camel tobaccos

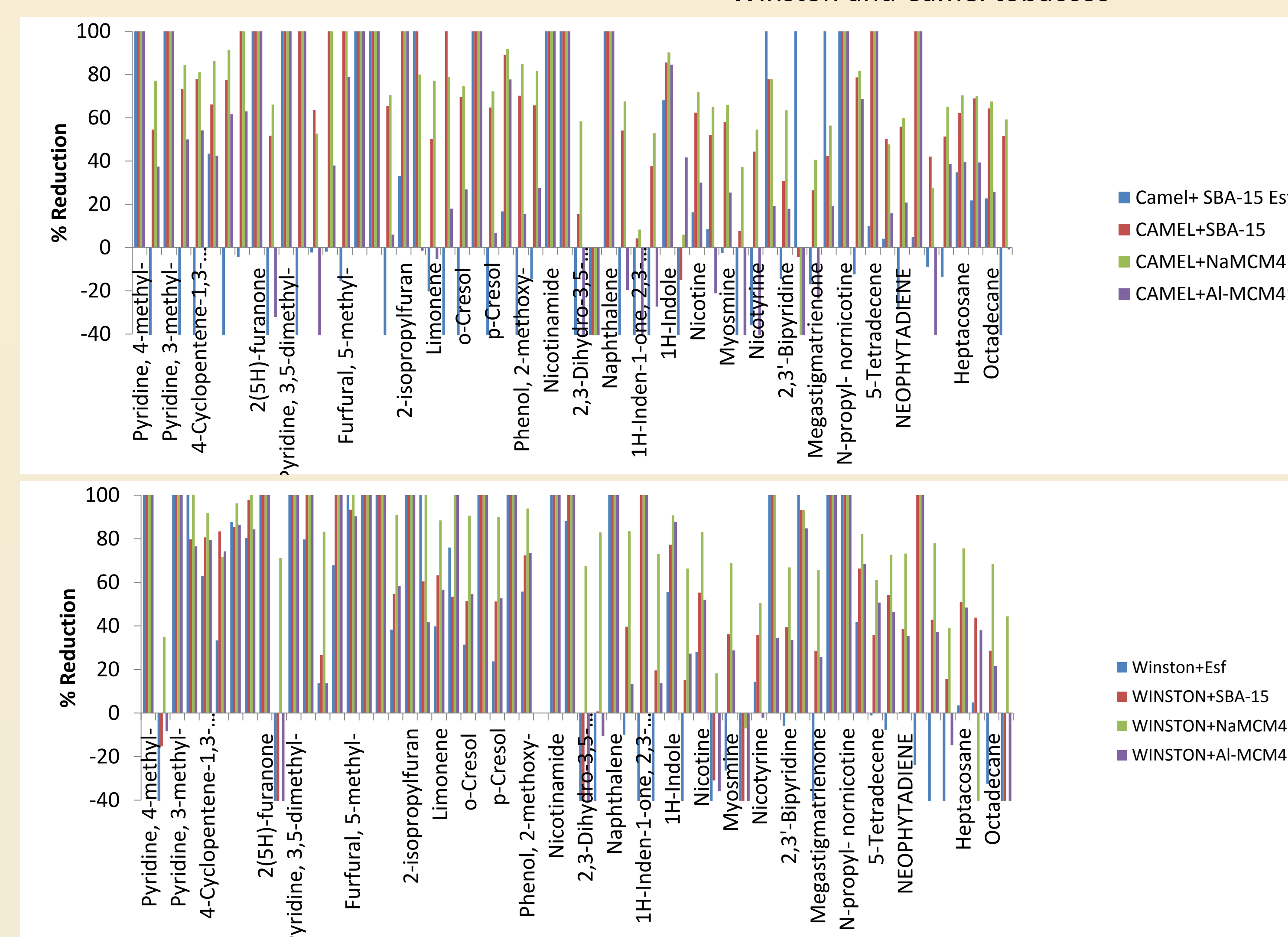


Figure 5. Reduction obtained in TPM-T for RYO tobaccos in presence of diferents catalyst

CONCLUSIONS

- The catalyst SBA Esf presents important reductions in the formation of condensed products (TPM-T) specially for Pueblo and Marlboro Brands
- An important reduction in Nicotine was observed for Pueblo RYO brand, for the rest of brands a reduction between 20-30 % were obtained
- The reduction of CO is the minor than gases and TPM-T, and for Marlboro and Cross Road RYO brand, and increase in the formation on CO was observed.
- The catalyst that presents major reductions in the condensed fraction (TPM-T) is NaMCM-41, following of SBA-15.
- The catalysts that presents minor activity is SBA Esf and Al-MCM41
- All the catalyst are capable of reduce noticeable two fraction analyzed, gases (CO and gaseous compounds), and condensed fraction (TPM-T and Nicotine).