

### **ST 3 - Delarue - Assessmt. of smokers' T&N yields under natural smoking conditions: comparison between smokers of full flavour & superlight cigarettes.**

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#### **Assessment of smokers ' tar and nicotine yields under natural smoking conditions : comparison between usual smokers of full flavour and superlight cigarettes.**

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#### Abstract

Last year, we described a new way of assessing tar and nicotine yields obtained under natural smoking conditions. This first study showed a concordance between the ISO yields and the average yields obtained under natural conditions by usual full flavour cigarette smokers (n=61), with huge inter-individual variations. The aims of the present study were :

- \* To compare the smoking behaviour of usual full (F), light (L) or superlight (S) cigarette smokers
- \* To assess their respective average tar and nicotine yields obtained under natural conditions
- \* To compare these yields to each other or with the respective ISO yields.

We asked 90 usual smokers of 3 main commercial brands of F, L, or S cigarettes in France to participate in the study. No inter-group difference appeared in the daily cigarette consumption. First of all, we analysed the way of smoking of each subject by using a Smoking Puff Analyser. We observed no inter-group difference in the number of puffs, the interval between puffs, but mean puff volume was significantly higher in the S group than in F or L. Duplication of each smoking profile was performed as a second step in order to determine the yields obtained under these laboratory conditions. Results for tar and nicotine yields were then F>L>S. We used these first laboratory results to evaluate the yields in natural conditions as described earlier. Once again, we observed that usual Full cigarette smokers produce an average of 11.7 mg tar and 0.87 mg nicotine, with no significant difference with the ISO yields. The usual Superlight cigarette smokers produce significantly much less tar and nicotine than the group F even though the difference is not as high as suggested by the ratio of ISO yields.

**Key Words :** smoker, puffing parameters, nicotine, tar, laboratory smoking conditions, natural smoking conditions

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#### Introduction

Last year, we presented a new way of assessing tar and nicotine yields obtained by smokers under natural smoking conditions. In this study, we showed that, on average, the usual smokers (n=61) of 2 different full flavour commercial brands produced 12.1 mg tar and 0.91

mg nicotine from their cigarettes (the ISO yields were 12 mg tar and 0.9 mg nicotine).

The aims of this new study were to confirm the concordance between the average yields obtained by smokers and those written on the packet for full flavour cigarette smokers, to compare the smoking behaviour of usual and exclusive smokers of full flavour (F), light (L) or superlight (S) cigarettes, to assess these smokers' tar and nicotine yields under natural smoking conditions and to compare them with the ISO yields.

## Material and methods

### **Cigarette characteristics**

Three commercial american blend cigarettes of a same brand from the French market were studied : a full one (F) : 12 mg tar and 0.9 mg nicotine ; a light one (L) : 8 mg tar and 0.6 mg nicotine ; a superlight one (S) : 3.9 mg tar and 0.38 mg nicotine.

### **Smoker characteristics**

30 usual smokers of each of these brands (n=90) were included in the study according to the following criteria : female, over 18 years old, exclusive smoker of these brands for at least 2 years, consuming from 10 to 30 cigarettes per day, inhaling the smoke (criteria used : carboxyhemoglobinemia higher than 3% after 4 p.m.), voluntarily participating in the study.

### **General schedule**

Subjects were included in the study according to the above criteria. They were informed on the aims of the study and a pulmonary X-ray was performed to check that they had no chest dysfunction. They were asked to note exactly the number of cigarettes that they had smoked the day before their laboratory smoking behaviour measurements, and to collect five of their butts for further analysis. Smoking behaviour measurement was performed in the laboratory on the first cigarette of the day (subjects smoking their own usual cigarette).

### **Measurement of the smoking behaviour**

The smoking behaviour of each subject was determined using a smoking puff analyser (Sodim, France). Several parameters were measured and smoking profiles were recorded : number, mean volume, mean duration, mean flow rate of the puffs, total volume of smoke, mean duration between puffs, total duration of the smoking. Duplication of each smoking profile was undertaken in order to determine the tar and nicotine yields obtained by each smoker under these laboratory conditions. Before and after smoking a cigarette, Final End CO (ppm) was measured after holding one's breath for 20 s and HbCO (%) was assessed by using the equation :  $HbCO = 0.174 \text{ FECO} + 0.726$  (Radziszewski, Arch. Mal. prof., 1990, 51, 245-249). After smoking, we measured the filter coloration at 464 nm (after one night's incubation of the filter in isopropanol) = OD (optical density).

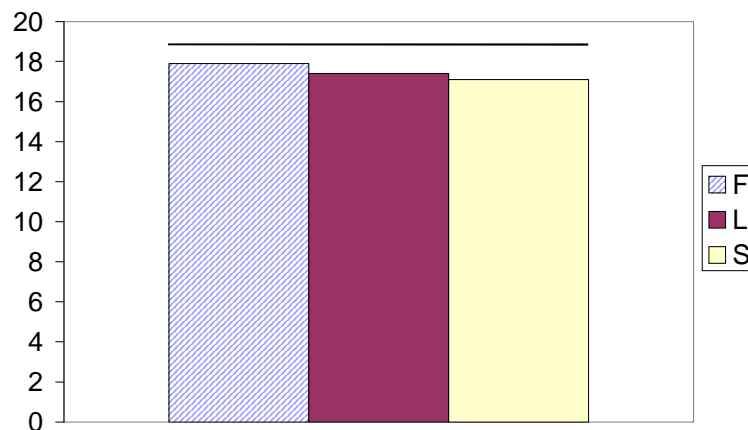
## Results and discussion

### **1. Smoking parameters**

### Daily consumption under natural conditions (figure 1a)

There is no significant difference between the 3 groups regarding the number of cigarettes that were smoked the day before the laboratory measurements. Superlight and light cigarette smokers, if they are usual consumers of these types of brands, do not smoke more cigarettes per day than usual consumers of full cigarettes.

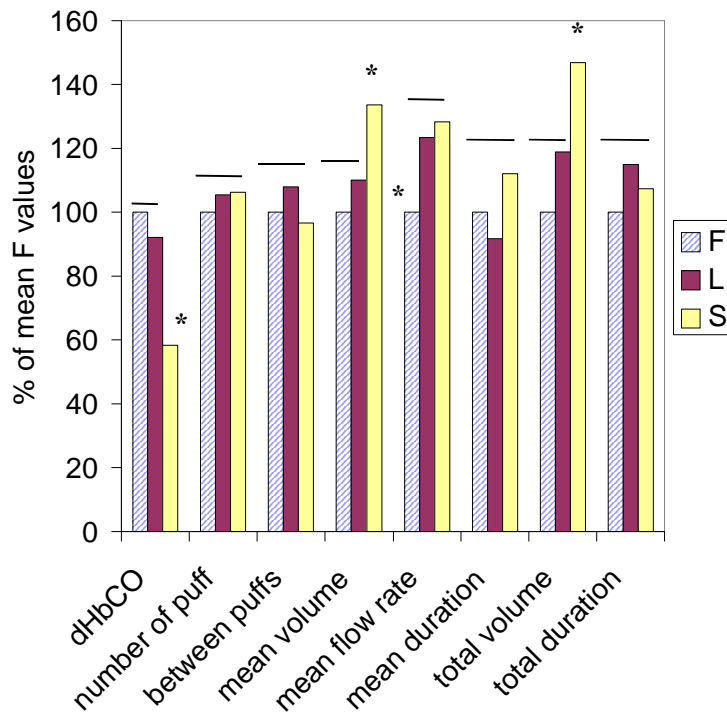
**Figure 1a : Number of cigarettes smoked per day**



### Smoking parameters (laboratory conditions) (figure 1b)

Delta HbCO (HbCO after smoking - HbCO before smoking) generated by smoking one cigarette is significantly lower in group S than in group F or L (only 58% increase in HbCO in group S compared to 100% in group F). No significant difference appears between the 3 groups regarding the number of puffs per cigarette or the mean interval between 2 puffs. Superlight cigarette smokers, if they are usual consumers of this type of brand, do not take more puffs per cigarette than usual consumer of full flavour or light cigarettes. The mean puff volume is higher in S than in F or L group (34% increase compared to F). The mean flow rate is lower in group F than in the 2 other groups (respectively 23 and 28% more for L and S). There is no difference between the groups for the mean puff duration. The mean total smoke volume is higher in group S than in groups F or L (47% increase compared to F). The mean total smoking duration is not different between the 3 groups.

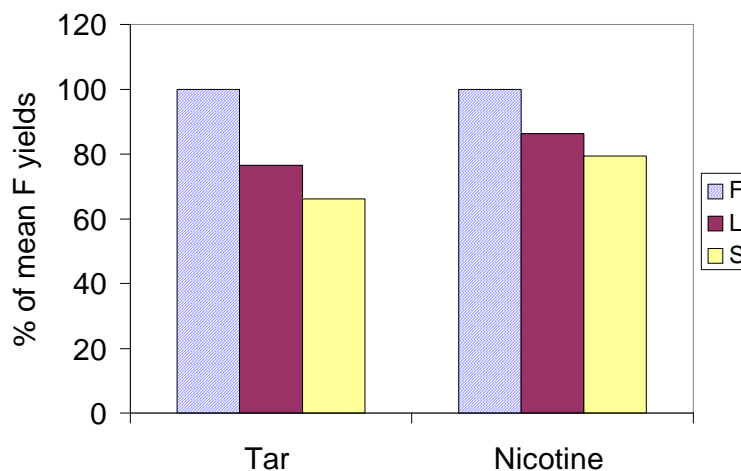
**Figure 1b : Smoking parameters (laboratory conditions) (expressed as % of mean F values)**



Tar and nicotine yields (laboratory conditions) (figure 1c)

The mean tar and nicotine yields are significantly lower for L than for F and lower for S than for L. Compared to F, we observed respectively 23% and 34% less tar for L and S and 14% and 21% less nicotine for L and S.

**Figure 1c : Laboratory tar and nicotine yields (expressed as % of mean F yields)**

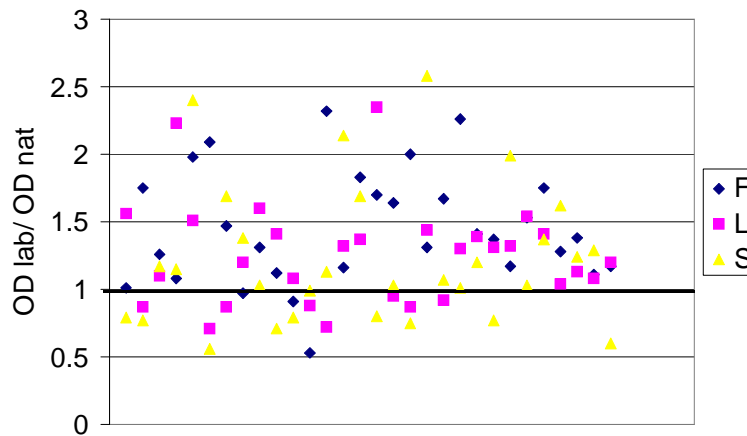


**2. Smoker behavioural changes under laboratory conditions**

If we compare the OD of the filter obtained under laboratory conditions (lab) to the mean OD of the five filters obtained under natural conditions (nat), we assess the extent of the smoker's behavioural changes : on average, smokers produce 31% more smoke under laboratory

conditions than under natural conditions (no difference between groups). In figure 2, details of the variation between OD lab and OD nat are shown : most of smokers smoke more under laboratory than under natural conditions (up to 2.6 times more), but some others produce less smoke under laboratory than they do under natural conditions (up to 2 times less).

**Figure 2 : Extent of change in smoking behaviour (OD lab/OD nat)**

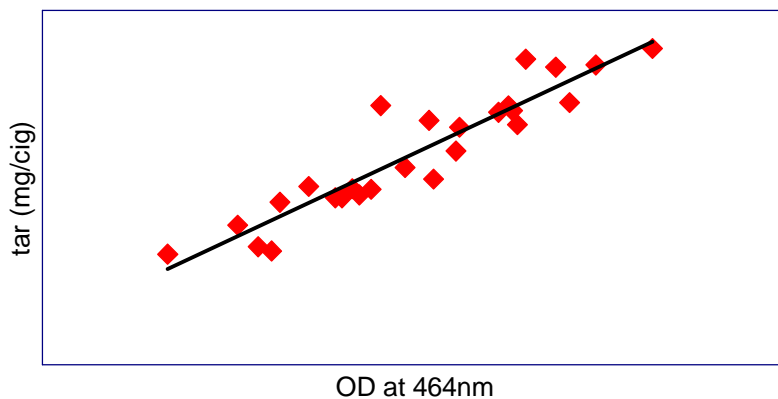


This highlights the fact that the results of such Smoking Puff Analysis studies should not solely be used to assess the individual's natural way of smoking. This is the reason why the results obtained under laboratory conditions have been presented in this study as relative values of the full group and not as absolute values.

### 3. Way of assessing yields obtained under natural conditions

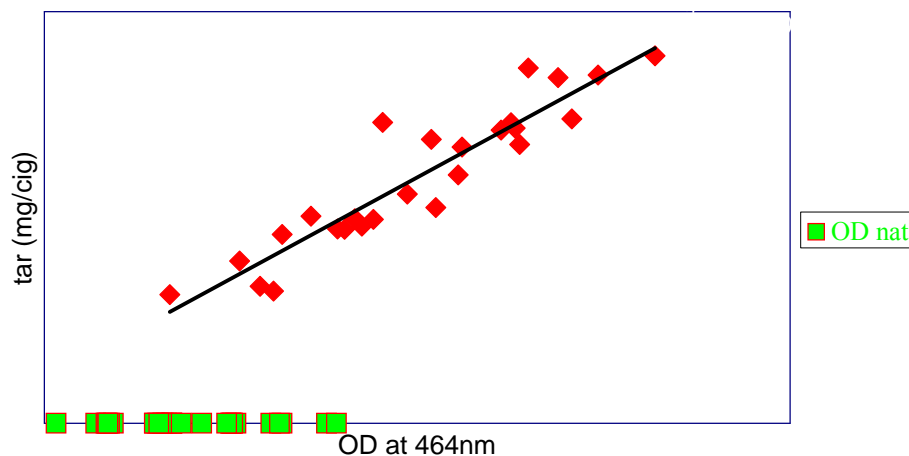
Interesting levels of correlation are observed between yields and OD after duplication of smoking profiles. For example, in the relation between tar and OD lab for the full flavour cigarette, the determination coefficient is 0.87 (figure 3a). (In this study, all the determination coefficients for tar and nicotine varied from 0.81 to 0.87 for the 3 groups).

**Figure 3a : Correlation between tar and OD lab for the F group**



By introducing the OD nat value in the regression equation, we assess the amount of tar that has been produced under natural conditions (figure 3b).

**Figure 3b : Assessment of the natural yields**



In fact, we use duplication as a step in the assessment of the natural yields. For this method to be used, we have to check the proximity of the range of values for OD nat with the range of values for OD lab. For the F and S groups, more than respectively 53% and 66% of the natural OD are included in the laboratory OD range, so assessment of yields obtained under natural conditions seems reasonable using our model (we can note that most of the OD nat values are lower than the OD lab values, which indicates lower yields). For the L group, only 26% of the natural OD values are included in the laboratory OD range, which makes the prediction of the yields obtained under natural conditions very unrealistic. For this reason, we decided to use the linear regression equations between yields (tar or nicotine) and OD to estimate the yields obtained by smokers under natural conditions (use of the mean OD obtained from the five filters given by the smokers) for the F and the S groups only.

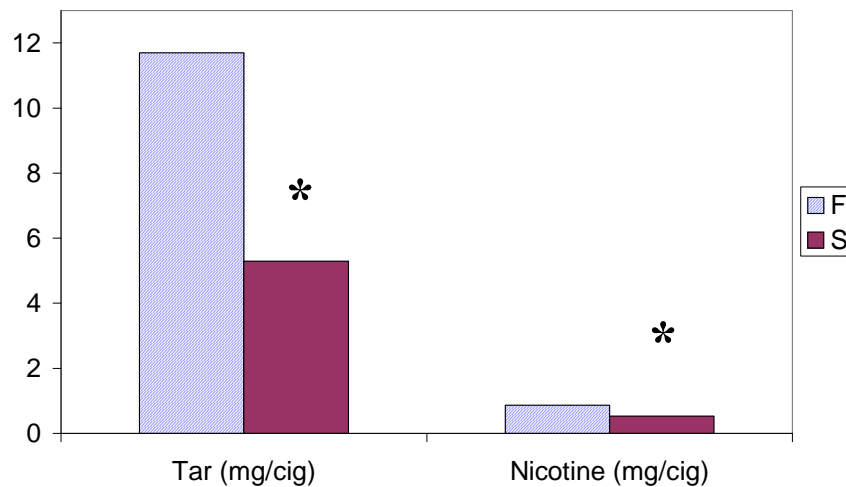
#### 4. Natural tar and nicotine yields

For the reasons given in paragraph 3, these assessments were made only for F and S groups.

##### F versus S (figure 4)

The mean yields of tar and nicotine obtained by smokers smoking their usual cigarette under natural conditions are significantly higher with a full cigarette than with a superlight cigarette.

**Figure 4 : Tar and nicotine yields under natural conditions**

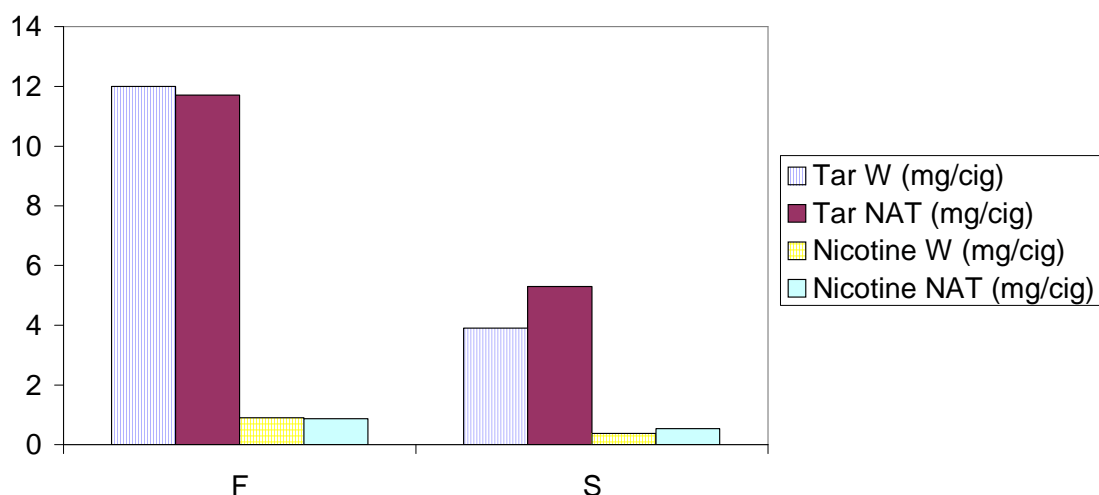


##### F or S versus ISO yields (figure 5)

The mean yields of both tar and nicotine obtained by smokers of one full cigarette under natural conditions are similar to the ISO yields (packet writing=W).

On the contrary, superlight cigarette smokers produce on average more tar and nicotine than the ISO yields.

**Figure 5 : F or S natural yields (NAT) versus ISO yields (W)**



### Summary of the results obtained with the 2 groups

Huge differences appear between smokers. But under natural conditions, usual smokers of the full brand produced an average of 11.7 mg tar and 0.87 mg nicotine, which is similar to the ISO yields. Usual smokers of the superlight brand produce an average of 5.3 mg tar and 0.54 mg nicotine, which is significantly lower than usual smokers of the full brand, but significantly higher than the ISO yields.

Value	F group				S group			
	ISO	mini	mean	maxi	ISO	mini	mean	maxi
Tar (mg/cig)	12.0	4.8	<b>11.7</b>	19.7	3.9	2.4	<b>5.3</b>	10.3
Nicotine (mg/cig)	0.90	0.51	<b>0.87</b>	1.29	0.38	0.33	<b>0.54</b>	0.90

### Conclusion

It is of crucial importance to keep in mind that smokers' behavioural changes appear under laboratory conditions : most of the time, they produce more smoke from their cigarette under laboratory conditions than under natural conditions (on average, in the present study, approximately 31% more smoke). That is why such laboratory smoking puff analyses are to be used very carefully. In this study, we specifically intended to assess the yields obtained under natural conditions. Our results confirm that usual smokers of full flavour cigarettes produce, under natural conditions, an average of 12 mg tar and 0.9 mg nicotine from their cigarette, which is very close to the yields obtained by ISO smoking. Compared to usual full cigarette smokers, usual superlight cigarette smokers do not increase their daily consumption. They produce significantly less tar and nicotine from their cigarette, even though the difference is not as high as suggested by the ratio of the ISO yields.