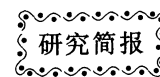


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烤烟不同部位烟叶主要化学成分与叶长的关系

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摘 要: 采集我国南方烟区 166 份烤烟品种 K326 不同部位叶样品, 研究烤烟主要化学成分与叶片长度的关系。结果表明: 烟碱、总氮、还原糖、钾、氯、氮碱比、糖碱比、钾氯比、叶长在样品间存在广泛的变异; 氯含量和钾氯比在部位间差异不显著, 叶长、烟碱含量、氮碱比和糖碱比在部位间差异显著; 总氮、还原糖含量在中部、下部叶间差异未达到显著水平, 但二者均与上部叶差异显著; 上部、中部叶的钾含量差异不显著, 但二者均与下部叶差异显著; 在一定范围内, 烤烟上部叶烟碱、总氮和钾含量随叶长的增加而增加, 氮碱比随叶长的增加而降低; 中部叶烟碱、还原糖、钾含量和钾氯比随叶长的增加而增加, 氯含量和氮碱比随叶长的增加而降低; 下部叶还原糖含量、糖碱比和钾氯比随叶长的增加而增加, 烟碱、总氮和氯含量随叶长的增加而下降。叶长 63.0 cm 对上部叶的烟碱、总氮含量和糖碱比与下部叶的钾、氯含量均是一个较为敏感的长度。

关键词: 烤烟; 叶位; 化学成分; 叶长; 关系分析

Relationship between Main Chemical Components in Leaf and Leaf Length in Different Positions in Tobacco (*Nicotiana tabacum* L.)

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Abstract: It is important for cigarette industry to get flue-cured tobacco leaves with accordant quality between agronomic characters and chemical components. Agronomic characters, however, are often inconsistent with chemical components, and this problem brings the difficulty of blending and decreases the benefits of cigarette industry. The purpose of this paper was to study the correlation between agronomic characters and chemical components and to provide theory basis for tobacco grading. By applying methods of descriptive statistics, ANOVA, multiple comparisons and degree distribution, 166 leaf samples of different positions including three grades of B₂F, C₃F, and X₂F from K326, a flue-cured tobacco cultivar widely planted in main tobacco areas in southern China, were selected as materials to study the relationship between chemical components and leaf length. The results indicated that there existed extensive variation among samples for chemical components and leaf length. The differences were not significant for chlorine content and ratio of potassium to chlorine (K₂O/Cl⁻), and were significant for leaf length, nicotine content, ratio of total nitrogen to nicotine (TN/nicotine) and ratio of reducing sugar to nicotine (RS/nicotine) among positions of flue-cured tobacco leaves. For total nitrogen and reducing sugar (RS) contents, cutters and lower leaf did not show significant difference, but both had significant difference with these in upper leaf. Similarly, for potassium (K₂O) content, these were non-significant difference in cutters and upper leaf, but significant difference in lower leaf. In the given range, the contents of nicotine, TN and K₂O increased with the increase of leaf length of upper leaf; however, TN/nicotine decreased with the increase of leaf length of upper leaf. The nicotine, RS, K₂O contents, and K₂O/Cl⁻ content increased with the increase of leaf length of cutters; Cl⁻ content and T N/nicotine decreased with the increase of leaf length of cutters. The RS content, RS/nicotine, and K₂O/Cl⁻ increased with the increase of leaf length of lower leaf; nicotine, TN and Cl⁻ content decreased with the increase of leaf length of lower leaf. More than 63.0 cm was a sensitive leaf length for nicotine, TN contents and RS/nicotine of upper leaf and K₂O and Cl⁻ content of lower leaf.

Keywords: Tobacco (*Nicotiana tabacum* L.) leaf; Stalk positions; Chemical components; Leaf length; Relationship analysis

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烟叶采购主要依据色泽、成熟度和部位等外观质量指标,但还必须考虑烟叶的可用性和主要化学成分的含量,以保证产品配方的精确性并使其具有较好的吸食品质^[1]。烤烟烟叶长度是反映叶片大小和营养水平高低的重要指标,它的变化与烟叶内在化学成分的变化具有较高的相关性^[2-3]。有关烤烟不同叶位化学成分变化规律的研究已有不少报道^[4-10],叶长与化学成分的关系也有研究^[11],但对烤烟不同叶位化学成分与叶长关系的系统研究较少。本试验旨在研究烤烟外观质量与内在质量的相关性,为烤烟分级和收购以及解决烤烟外观质量与内在质量的统一性提供理论依据。

1 材料与方法

1.1 试验材料

2003 年在我国南方烟区采取定等级方法对主产烟区

的主栽品种 K326 取样 166 份,包括中部叶 C₃F(中橘三) 54 份,上部叶 B₂F(上橘二) 56 份,下部叶 X₂F(下橘二) 56 份。样品等级由专职评级人员按照 GB 2635-1992《烤烟》标准评定,等级合格率达到 85%以上。每个样品取 3.0 kg,用于各项指标测定。

1.2 分析方法

参考王瑞新的方法测定烟碱、总氮、还原糖、钾和氯含量^[12];参考 GB 2635-1992《烤烟》测定烟叶叶长。采用 SPSS^[13]和 DPS^[14]软件统计分析数据。

2 结果与分析

2.1 烤烟不同部位主要化学成分与叶长的数量特征

由表 1 可以看出,烟碱、总氮、还原糖、钾、氯、氮碱比、糖碱比、钾氯比、叶长在样品间存在广泛的变异。在上部叶中,叶长的变异系数最小,仅为 8.0%,说明叶长

表 1 烤烟主要化学成分与叶长的统计分析
Table 1 Statistical parameters of main chemical components in leaf and leaf length in flue-cured tobacco

部位 Position	指标名称 Index	样本数 No. of samples	变幅 Range	平均值 Mean	标准偏差 SD	峰度系数 Kurtosis	偏度系数 Skewness
上部叶 Upper leaf	叶长 Leaf length(cm)	56	49.50-72.60	60.02	4.81	0.42	0.61
	烟碱 Nicotine(%)	56	2.06-5.18	3.77	0.75	0.19	-0.39
	总氮 TN(%)	56	1.23-2.25	1.77	0.26	-0.74	-0.05
	还原糖 RS(%)	56	14.66-28.52	23.19	3.24	-0.07	-0.92
	钾 K ₂ O(%)	56	0.61-3.58	2.05	0.63	-0.79	0.06
	氯 Cl ⁻ (%)	56	0.05-1.73	0.34	0.35	12.59	3.39
	氮碱比 TN/nicotine	56	0.35-0.99	0.49	0.11	6.35	2.01
	糖碱比 RS/nicotine	56	2.83-12.33	6.52	2.03	0.74	0.81
	钾氯比 K ₂ O/Cl ⁻	56	0.58-53.67	12.57	10.84	4.31	2.02
中部叶 Cutters	叶长 Leaf length(cm)	54	54.40-76.70	62.38	4.69	0.85	0.80
	烟碱 Nicotine(%)	54	1.46-5.11	2.82	0.73	0.51	0.43
	总氮 TN(%)	54	1.20-2.16	1.56	0.19	0.39	0.40
	还原糖 RS(%)	54	18.91-35.56	25.21	2.60	4.63	0.91
	钾 K ₂ O(%)	54	0.98-3.58	2.25	0.66	-0.79	0.06
	氯 Cl ⁻ (%)	54	0.05-1.73	0.28	0.33	12.59	3.39
	氮碱比 TN/nicotine	54	0.36-0.99	0.58	0.14	0.50	0.89
	糖碱比 RS/nicotine	54	3.70-18.77	9.65	3.12	0.54	0.87
	钾氯比 K ₂ O/Cl ⁻	54	0.58-50.33	14.57	10.30	2.06	1.23
下部叶 Lower leaf	叶长 Leaf length(cm)	56	46.20-68.20	56.05	4.68	0.05	0.20
	烟碱 Nicotine(%)	56	1.44-3.94	2.31	0.52	0.74	0.56
	总氮 TN(%)	56	1.13-1.94	1.51	0.20	-0.21	0.46
	还原糖 RS(%)	56	13.85-31.05	24.59	2.61	5.03	-1.20
	钾 K ₂ O(%)	56	1.06-4.36	2.54	0.83	-0.78	0.07
	氯 Cl ⁻ (%)	56	0.03-1.40	0.28	0.28	6.35	2.45
	氮碱比 TN/nicotine	56	0.45-1.10	0.68	0.16	0.01	0.95
	糖碱比 RS/nicotine	56	4.01-16.97	11.19	2.82	-0.25	0.22
	钾氯比 K ₂ O/Cl ⁻	56	0.76-72.67	17.92	16.08	4.31	2.02

TN: total nitrogen; RS: reducing sugar.

比较稳定;最大的变异系数为氯,达到 103.8%,其次为钾氯比,变异系数是 86.2%;烟碱、总氮、还原糖、钾的峰度系数是负数,它们的数据分布为平阔峰,比较分散,其余指标的数据分布为尖峭峰,相对集中;烟碱、总氮、还原糖的偏度系数小于 0,为负向偏态峰,其余指标为正向偏态峰。

在中部叶中,叶长的变异系数也最小(7.5%),变异系数最大的仍然是氯(116.0%),其次为钾氯比(70.7%);峰度系数除钾为平阔峰外,其余的均为尖峭峰;偏度系数均为正向偏态峰。同样,下部叶叶长的变异系数也最小(8.4%),氯的变异系数也最大(101.4%),其次是钾氯比(89.7%);下部叶总氮、钾、糖碱比的峰度系数小于 0,数据分布为

平阔峰,其余为尖峭峰;下部叶偏度系数除还原糖小于 0 为负向偏态峰外,其余指标为正向偏态峰。3 个部位中,上部叶烟碱含量出现次数最多的数值为 4.44%,中部叶为 2.86%,下部叶为 2.10%。

2.2 烤烟不同部位主要化学成分与叶长的方差分析和差异显著性检验

由表 2 结果可知,氯和钾氯比部位差异不显著,其余指标部位间差异均达到显著水平。表 3 表明,叶长、烟碱、氮碱比和糖碱比在 3 个部位间的差异显著;总氮、还原糖在中部、下部间的差异未达到显著水平,但二者均与上部叶差异显著;上部、中部叶的钾含量差异不显著,但二者均与下部叶差异显著。

表 2 烤烟不同部位叶主要化学成分与叶长方差分析
Table 2 ANOVA for main chemical components in leaf and leaf length in different positions in flue-cured tobacco

指标 Index	组间平方和 Sum of squares between groups	组内平方和 Sum of squares within groups	F 值 F-value	相伴概率 P
叶长 Leaf length (cm)	1127.847	3643.567	25.228	0.000
烟碱 Nicotine (%)	61.108	74.170	67.148	0.000
总氮 TN (%)	2.108	7.839	21.922	0.000
还原糖 RS (%)	118.125	1308.514	7.357	0.001
钾 K ₂ O (%)	7.004	83.508	6.836	0.001
氯 Cl ⁻ (%)	0.125	16.832	0.606	0.547
氮碱比 TN/nicotine	1.053	3.189	26.908	0.000
糖碱比 RS/nicotine	633.501	1180.072	43.752	0.000
钾氯比 K ₂ O/Cl ⁻	818.978	26304.187	2.537	0.082

表 3 烤烟不同部位叶主要化学成分与叶长的多重比较
Table 3 Multiple comparisons for main chemical components in leaf and leaf length in different positions in tobacco

部位 Position	叶长 Leaf length(cm)	烟碱 Nicotine(%)	总氮 TN(%)	还原糖 RS(%)	钾 K ₂ O(%)	氮碱比 TN/nicotine	糖碱比 RS/nicotine
上部叶 Upper leaf	60.02 b	3.77 a	1.77 a	23.19 b	2.05 b	0.49 c	6.52 c
中部叶 Cutters	62.38 a	2.82 b	1.56 b	25.21 a	2.25 b	0.58 b	9.65 b
下部叶 Lower leaf	56.05 c	2.31 c	1.51 b	24.59 a	2.54 a	0.68 a	11.19 a

同一列标有不同字母的值差异达到 5% 显著水平。
Values followed by a different letter in a column are significantly different at 5% probability level.

2.3 烤烟不同叶位主要化学成分与叶长的关系

2.3.1 烟碱、总氮、氮碱比与叶长 图 1 和图 2 说明,烟碱、总氮、氮碱比与叶长的变化规律在不同部位间差异较大。图 1 表明,随叶长的增加,烤烟上部叶和中部叶的烟碱含量整体呈上升趋势,下部叶的烟碱含量呈下降趋势,其中,上部叶叶长在大于 63.0 cm (61.5~64.5 cm 的组中值,下同)后,烟碱含量增加较快;中部叶烟碱含量随叶长增加而平缓上升;下部叶叶长在大于 56.8 cm (55.3~58.3 cm 的组中值,下同)后,烟碱含量下降明显,这与以往研究的烟碱含量随叶片增大而逐渐增加的结论不尽一致^[11]。

图 1 还表明,上部叶总氮随叶长的增加总体呈上升趋势;而下部叶总氮含量则随叶长的增加总体呈下降趋势;中部叶总氮含量随叶长的变化波动较大,变化规律

不明显。上部叶叶长在大于 63.0 cm 后,总氮含量增加幅

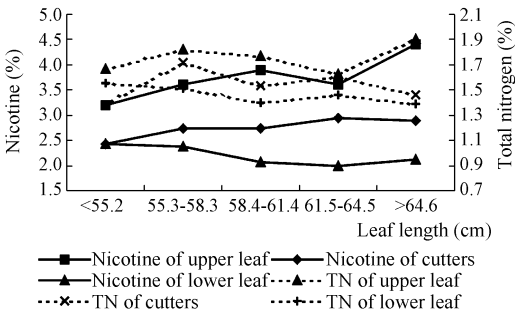


图 1 不同部位叶烟碱、总氮含量与叶长之间的关系
Fig. 1 Relationship between nicotine, TN contents in leaf and leaf length in different positions

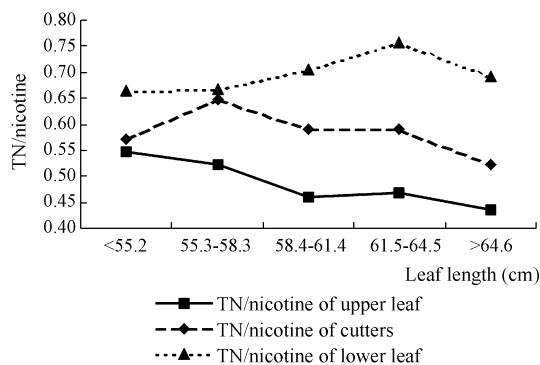


图2 不同部位叶氮碱比与叶长之间的关系

Fig. 2 Relationship between TN/nicotine in leaf and leaf length in different positions

度较大,这与以前的研究结论部分一致。已有研究^[11]认为,除上部叶总氮含量随叶长增长而略有增加外,叶长与烟叶总氮含量的变化规律不明显。出现这种差异的原因可能与是否对叶长进行分组比较有关。

由图2可见,上部、中部氮碱比随叶长增加而下降;下部叶氮碱比随叶长的增加,先上升后下降。这与以前的研究结论基本一致,有研究^[2]认为相同部位的烟叶,一般随叶长的增加氮碱比下降。此外,与氮碱比的合适区域相比较^[2],图2显示的氮碱比偏低,这与烟碱含量较大有关。

2.3.2 还原糖、糖碱比与叶长 图3表明,上部叶还原糖随叶长的变化波动较大,变化规律不明显;中部叶和下部叶还原糖含量随叶长的增加整体呈上升趋势。中部叶叶长>56.8 cm、下部叶叶长>59.9 cm (58.4~61.4 cm的组中值,下同)后,还原糖含量明显增加。从图3还可以看出,上部叶在叶长>63.0 cm后,糖碱比下降明显。中部叶糖碱比随叶长变化平缓,下部叶糖碱比随叶长增加明显上升。

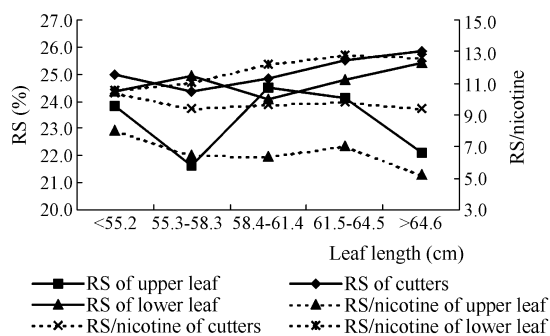


图3 不同部位叶还原糖、糖碱比与叶长之间的关系

Fig. 3 Relationship between RS, RS/nicotine in leaf and leaf length in different positions

2.3.3 钾、氯、钾氯比与叶长 由图4可见,上部、中部叶钾含量随叶长的增加整体呈上升趋势,下部叶钾含量随叶长增加先上升后下降,在叶长>63.0 cm后明显下降。上部叶氯含量随叶长变化波动较大,变化规律不明显;中部叶、下部叶氯含量随叶长增加整体呈下降趋势,尤其在叶长>63.0 cm后,有一个迅速下降的趋势。由图5可以

看出,上部叶钾氯比波动较大,变化规律不明显;中、下部叶钾氯比随叶长增加整体呈上升趋势,在叶长>56.8 cm后,上升趋势明显。

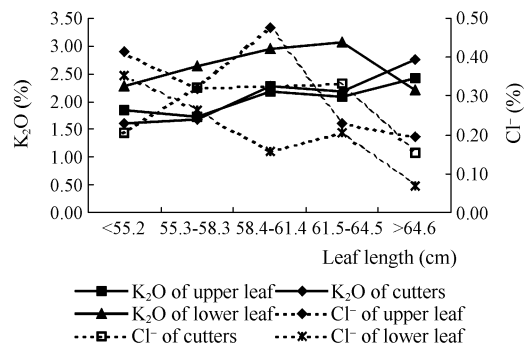


图4 不同部位叶钾、氯含量与叶长之间的关系

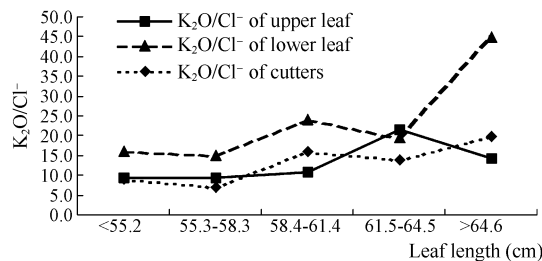
Fig. 4 Relationship between K_2O , Cl^- contents in leaf and leaf length in different positions

图5 不同部位叶钾氯比与叶长之间的关系

Fig. 5 Relationship between K_2O/Cl^- in leaf and leaf length in different positions

3 讨论

由川芳等^[7]研究认为,氯含量按部位由上到下呈现出下降的趋势,顶叶及上部叶含量较高;但王东胜等^[2]研究认为,氯含量表现为底部叶最高,顶部叶次之,中部叶最低,这些结论相互矛盾的原因可能既与样本数量有关,也与仅对数据平均值进行比较,而未对数据进行分组分析有关。

氮碱比的大小与烟叶成熟过程中氮素转化为烟碱的程度有关,因此可在一定程度上反映烟叶的成熟状况。烤烟的氮碱比值一般在0.8~1.1之间,以1.0较为合适^[2]。糖碱比主要反映烟气的生理强度和醇和度,是评价烟叶吃味的一项重要指标。应用这一指标,一方面要求糖和烟碱两种成分的含量适宜,另一方面要求两者之间保持一定的比例^[2]。有研究^[15]认为,烟碱等含氮化合物随部位升高而增加。也有研究^[16]认为,不同部位烟叶还原糖含量以中部叶最多,上部叶次之,下部叶最少。这些研究均只是进行了各化学成分绝对值的简单比较,未在统计水平上进行分析,因而造成了一些研究结果上的差异。

钾氯比主要用于判定烟叶的燃烧性。比值越大,烟叶的燃烧性越好^[2]。叶长63.0 cm对上部叶的烟碱、总氮和糖碱

比, 以及下部叶的钾、氯含量都是一个较为敏感的长度。

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