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THE PRECISION OF A PUSH BUTTON PIPETTE CAN BE DETERMINED BY TWO DIFFERENT SMALL SAMPLE TESTS

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Abstract:
Testing of the precision of a push button pipette can be determined by two different small sample tests. Namely t – test and F – test.

Keywords:
Small sample (n<30), t-test, F- test push button pipette.

Introduction:
Mechanical Dispensers: These operate in a similar manner to the integral syringe and reagent bottle, except that the syringe plunger is driven mechanically by an electric motor. This offers more control over the ejection step and is less tiring for repetitive use.

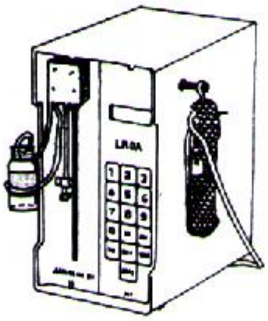

Fig 1: Mechanical Dispenser

Standardizations of a push button pipette
The precision of a push button pipette can be determined by the following simple experiment.

- Requirements

1. 50mg/dl gention violet solution
2. Distilled water
3. Test tubes: 15 x 125 mm.
4. 50 µl push-button pipette.
5. photometer or spectrophotometer

- Procedure

1. Label the test tubes (No.1 to 10).
2. Pipette 5.0 ml distilled water in each test tube.
3. Add 0.05µl of gention violet solution in each tube by using the push-button pipette, mix well.
4. Read intensities of each solution at 520nm (green filter) against blank (distilled water).

1. **t- test for single sample:**

Lable the test tubes $x_1, x_2, x_4, \ldots x_n$, from a normal push button pipette we have to test the hypothesis that mean of the push button pipette is µ. For this,

we first calculate $t = \left(\bar{x}-\mu\right)\sqrt{n}/\sigma_s$

Where

$$\bar{x} = \frac{1}{n}\sum_1^n x_{i,}\sigma_s^2 = \frac{1}{n-1}\sum_1^n\left(x_i-\bar{x}\right)^2$$

Then find the value of P for the given degrees of freedom from the table.

If the calculated value of t > $t_{0.05}$, the difference between $\bar{x}\, and\, \mu$ is said to be significant at 5% level of significance.

If t > $t_{0.01}$, the difference is said to be significant at 1% level of significance.

It t > t $_{0.05}$, the data is said to be consistent with the hypothesis that µ is the mean of the push button pipette .

2. **t- test for two small samples:**

Given two test tubes of sizes n_1 and n_2. $x_1, x_2, x_3, \ldots, x_{n1}$, and $y_1, y_2, \ldots, y_{n2}$ with means $\bar{x}\, and\, \bar{y}$ and standard deviation

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$\sigma_x and \sigma_y$ from a normal push button pipette with the same variance, we have to test the hypothesis that the push button pipette means $\mu_1 and \mu_2$ are the same.

For this, we calculate

$$t = \frac{\vec{x} \sim \vec{y}}{\sigma\sqrt{\left(\frac{n}{n_1}+\frac{n}{n_2}\right)}}$$

Where $\vec{x} = \frac{1}{n_1}\sum_1^{n_1} x_i, \bar{y} = \frac{1}{n_2}\sum_1^{n_2} y_i$

And

$$\sigma_s^2 = \frac{1}{n_1+n_2-2}\left[(n_1-1)\sigma_x^2+(n_2-1)\sigma_y^2\right]$$

$$= \frac{1}{n_1+n_2-2}\left\{\sum_1^{n_1}(x_i-\bar{x})^2+\sum_1^{n_2}(y_j-\bar{y})^2\right\}$$

It can be shown that the variety t defined by (1) follows the t-distribution with $n_1 + n_2 - 2$ degrees of freedom.

If the calculated value of t > $t_{0.05}$, the difference between the sample means is said to be significant at 5% level of significance.

If t> $t_{0.01}$, the difference is said to be significant at 1% level of significance.

If t < $t_{0.05}$, the data is said to be consistent with the hypothesis, that $\mu_1 and \mu_2$.

3. **t-test for two small sample with same size**

Cor. If the two samples are of the same size and the data are paired, then t is defined by

$$t = \frac{\bar{d}-0}{\left(\sigma/\sqrt{n}\right)} where\, \sigma^2 = \frac{1}{n-1}\sum_1^n (d_i-\bar{d})^2$$

D_i = difference of the *ith* members of the samples;

$\bar{d}$ = mean of the difference = $\sum d_i/n$; and the number of d.f. = n – 1.

4. **F – test for determined the precision of a push button pipette:**

Let $x_1, x_2, \ldots\ldots x_{n1}$ and $y_1, y_2, \ldots. y_{n2}$ be the values of two independent random samples drawn from the normal push button pipette σ^2 having equal variances

Let $\bar{x}_1 \, and \, \bar{x}_2$ be the samples means and

$$s_1^2 \frac{1}{n_1-1}\sum_1^{n_1}(x_i-\bar{x})^2 \; s_2^2 = \frac{1}{n_2-1}\sum_1^{n_2}(y_i-\bar{y})^2$$

be the sample variance.

Then we define F by the relation

$$F = \frac{s_1^2}{s_2^2}$$

This gives F – distribution (also known as variance ratio distribution) with $y_1 = n_1 - 1$ *and* $y_2 = n - 2$ degrees of freedom. The larger of the variances is placed in the numerator.

Significance test:

Snedecor's F – tables give 5% and 1% points of significance for F. 5% points of F mean that area under the F – curve to the right of the ordinate at a value of F, is 0.05. Clearly value of F at 5% significance is lower than that at 1%. F – distribution is very useful for testing the equality of push button pipette means by comparing sample variances. As such it forms the basis of analysis of variance.

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