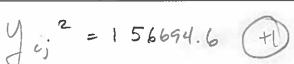
It is believed that there is a relationship between pH and tannin content in µg/mL of a specific craft beer made by Yellow Springs Brewery. 21 beers were tested for tannin content at three pH levels and then heroically and altruistically consumed by the on-site chemists -- in the name of science!! The results are presented below:

SOLUTIO.

рН	Tannin Level (μg/mL)								A 10 . 44 A
	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	TOTALS	average
5.15	82.2	79.2	79.9	80.3	81.4	79.5	80.9	563.4	80.49
5.45	88.2	89.4	87.3	84.8	86.5	88.4	84.6	609.2	87.03
5.75	92.2	93.6	97.7	94.3	83.6	85.0	91.6	638	91.14
1000					No Carlo		91377	1810.6	86.22

Use Analysis of Variance (ANOVA) to test the null hypothesis that the treatment means are equal at the α = level of significance. Fill in the ANOVA table.

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	f ₀	
Treatments	404.4	2_	202,2	90.0.	
Error	182	18	10.11	•	
Total	586,4	20	•	•	



$$f = \frac{202,2}{10.11} = 20.0 (+1)$$



Write a 95% confidence interval on tannin content at the 5.15 pH level. Include a unit with your answer.

 $M_{5.15}$: $80.49 \pm t.025, 18 \sqrt{\frac{10.11}{7}}$ (A) = 2.101 (A)

77.97 < M5.15 < 83.01

[ug/m]

Use Fisher's Least Significant Difference to determine which, if any, pairs of treatment means show significant difference at $\alpha = 0.05$.

$$LSD = t.625,18 \qquad 2.10.11 \\ = 2.101$$

$$= 3.57 \qquad (1)$$

5.15 Vs. 5.45:
$$|\overline{y}_{1} - \overline{y}_{2}| = |80.49 - 87.03| = |6.54| > LSD$$

5.45 Vs. 5.75: $|\overline{y}_{2} - \overline{y}_{3}| = |87.03 - 91.14| = |4.11| > LSD$

5.15 Vs. 5.75: $|\overline{y}_{1} - \overline{y}_{3}| = |80.49 - G||.|4| = |10.65| > LSD$

911 Pairs Show significant difference in tannin condent.

all pairs show significant différence in tannin content (H)

Formulae:

$$SS_T = \sum_{i=1}^{a} \sum_{j=1}^{n} y_{ij}^2 - \frac{y_{i}^2}{N}$$
 with an -1 degrees of freedom

$$SS_{Treatments} = \sum_{i=1}^{a} \frac{y_{i}^{2}}{n} - \frac{y_{i}^{2}}{N}$$
 with $a-1$ degrees of freedom

 $SS_E = SS_T - SS_{Treatments}$ with a(n-1) degrees of freedom

$$MS_{Treatments} = \frac{SS_{Treatments}}{a - 1}$$

$$MS_E = \frac{SS_E}{a(n-1)}$$

$$f_0 = \frac{MS_{Treatments}}{MS_E}$$

$$f_{critical} = f_{\alpha,\alpha-1,\alpha(n-1)}$$

CI on
$$\mu_i$$
: $\bar{y}_i \pm t_{\alpha/2,a(n-1)} \sqrt{\frac{MS_E}{n}}$

CI on
$$\mu_l - \mu_j$$
: $\bar{y}_{l\cdot} - \bar{y}_{j\cdot} \pm t_{\alpha/2,a(n-1)} \sqrt{\frac{2MS_E}{n}}$

$$LSD = t_{\alpha/2, \alpha(n-1)} \sqrt{\frac{2MS_E}{n}}$$