1.

Source	DF	SS	MS	F	p-value
Between	4	600.86	150.035	133.96	< 0.0001
Within	25	28	1.12		
Total	29	628.14	21.66		

$$\text{Total SS} = 29 \times \text{MSTotal} = 29 \times 21.66 = 628.14 \text{ kg}^2$$

~~Within SS~~

$$\text{MSWithin} = \frac{\left((6-1)\times 1.10^2 + (6-1)\times 0.89^2 + 5\times 1.41^2 + 5\times 1.10^2 + 5\times 0.63^2\right)}{25}$$

$$= \frac{5 \times 5.597}{25} = 1.12 \text{ kg}^2$$

$$\text{SS Within} = 25 \times 1.12 = 28$$

$$\text{SS Between} = \text{Total SS} - \text{SSwithin} = 628.14 - 28 = 600.14$$

$$\text{MS Between} = \frac{\text{SS Between}}{\text{df Between}} = \cancel{\frac{599.86}{4}} = \frac{600.14}{4} = 150.035$$

$$\text{F-ratio} = \frac{\text{MS Between}}{\text{MS Within}} = \frac{150.035}{1.12} = 133.96$$

2. The F-ratio is 133.96 with 4 and 25 d.f.'s. The p-value is < 0.0001 and provides strong evidence that the treatment means are not all equal.

3. Test for a supplement effect:

If $\mu_0, \mu_{20}, \mu_{40}, \mu_{60}$ and μ_{80} denote the mean weight gains for 0, 20, –, 80 gm/kg of dietary supplement, the contrast we want to test:

$$\gamma = \frac{\mu_{20} + \mu_{40} + \mu_{60} + \mu_{80}}{4} - \mu_0$$

$$\hat{\gamma} = \frac{26 + 30 + 33 + 34}{4} - 22 \text{ kg}$$

$$= \frac{123}{4} - 22 = 30.75 - 22 = 8.75 \text{ kg.}$$

$$SE(\hat{\gamma}) = \hat{\sigma} \times \sqrt{\frac{(-1)^2}{6} + \frac{(\frac{1}{4})^2}{6} \times 4}$$

$\hat{\sigma} = \sqrt{MSE}$
$= \sqrt{1.12}$
$= 1.058$

$$= 1.058 \times \sqrt{\frac{1}{6} + \frac{1}{24}}$$

$$= 1.058 \times \frac{\sqrt{5}}{2 \times \sqrt{3}} = 0.683 \text{ kg.}$$

$$\text{T-ratio} = \frac{\hat{\gamma}}{SE(\hat{\gamma})} = \frac{8.75}{0.683} = 12.81$$

with $df = 25$

p-value < 0.0001

Conclusion: There is a very strong evidence for a supplement effect.

4. LTC:

	0	20	40	60	80
avg.			40		
	−40	−20	0	20	40

$$\gamma_L = -40\mu_0 - 20\mu_{20} + 0.\mu_{40} + 20\mu_{60} + 40\mu_{80}$$

$$\hat{\gamma}_L = -40\times 22 - 20\times 26 + 0 + 20\times 33 + 40\times 34$$

$$= 620 \text{ kg}$$

$$SE(\hat{\gamma}_L) = 1.058 \times \sqrt{\frac{40^2}{6} + \frac{20^2}{6} + \frac{0^2}{6} + \frac{20^2}{6} + \frac{40^2}{6}}$$

$$= \frac{1.058}{\sqrt{6}} \times \sqrt{4000} = \frac{1.058 \times 20 \times \sqrt{10}}{\sqrt{6}}$$

$$= 27.317 \text{ kg}.$$

$$T = \frac{620}{27.317} = 22.696 \text{ with } df = 25$$

p-value < 0.0001 providence strong evidence ~~for~~ against the equality of means in favour of a ~~[illegible]~~ increasing linear trend.