

Lampiran 2. Perhitungan

Tabel 13. Analisis ragam kekerasan butiran tiwul

Perlakuan	Ulangan			Total	Rata-rata
	I	II	III		
A	0,051	0,048	0,042	0,141	0,047
B	0,048	0,045	0,040	0,133	0,044
C	0,055	0,050	0,042	0,147	0,049
D	0,059	0,053	0,044	0,156	0,052
Total	0,213	0,196	0,168	0,577	0,192
Rata-rata	0,053	0,049	0,042	0,144	0,048

Perhitungan :

1. FK $= Y^2 / r \times p$
 $= (0,577)^2 / (3 \times 4)$
 $= 0,0277$
2. JK Total $= \sum_i \sum_j (Y_{ij} - \bar{Y}_{..})^2 - FK$
 $= (0,051)^2 + (0,048)^2 + (0,042)^2 + \dots + (0,044)^2 - 0,0277$
 $= 0,0281 - 0,0277$
 $= 0,00041$
3. JK Kelompok $= p \sum_j (\bar{Y}_{.j} - \bar{Y}_{..})^2 - FK$
 $= (0,213^2 + 0,196^2 + 0,168^2) / 4 - 0,0277$
 $= 0,0280 - 0,0277$
 $= 0,0003$
4. JK Perlakuan $= r \sum_i (\bar{Y}_{i.} - \bar{Y}_{..})^2 - FK$
 $= (0,141^2 + 0,133^2 + 0,147^2 + 0,156^2) / 3 - 0,0277$
 $= 0,0278 - 0,0277$
 $= 0,0001$
4. JK G Perc. $= JK \text{ total} - JK \text{ kelompok} - JK \text{ perlakuan}$
 $= 0,00041 - 0,0003 - 0,0001$
 $= 0,00001$
5. KT kelompok $= JK_k / (p - 1)$
 $= 0,0003 / 3 = 0,0001$
6. KT perlakuan $= JK_p / (r - 1)$
 $= 0,0001 / 2$
 $= 0,00005$
7. KT G Perc. $= JK_G / (r - 1) (p - 1) = 0,00001 / 6 = 0,000001$

Dari perhitungan di atas di dapatkan tabel analisis ragam :

Sumber keseragaman	db	JK	KT	Fhitung	Ftabel	
					0,05	0,01
Kelompok	2	0,0003	0,0001	100	5,14	10,92
Perlakuan	3	0,0001	0,00005	500	4,76	9,78
Galat percobaan	6	0,00001	0,000001			
Total	11	0,00041				

$$KK = \frac{S}{Y} \times 100\% = \frac{\sqrt{KT \text{ G Percobaan}}}{Y} \times 100\% = \frac{\sqrt{0,000001}}{0,048} \times 100\% = 2,08\%$$

Beda Nyata Terkecil :

$$\begin{aligned} \text{BNT (0,05)} &= t^{(0,05)/2}(6) \times \sqrt{(2 \times 0,000001)/4} \\ &= 2,447 \times 0,000707 \\ &= 0,0017 \end{aligned}$$

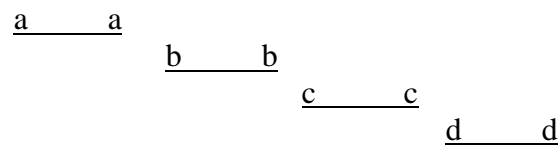
$$\begin{aligned} \text{BNT (0,01)} &= t^{(0,01)/2}(6) \times \sqrt{(2 \times 0,000001)/4} \\ &= 3,707 \times 0,000707 \\ &= 0,0026 \end{aligned}$$

Perlakuan dan nilai tengah	Perlakuan dan nilai tengah			
	(B)	(A)	(C)	(D)
	0,044	0,047	0,049	0,052
(B) 0,044	-	0,003	0,005	0,008
(A) 0,047		-	0,002	0,005
(C) 0,049			-	0,003
(D) 0,052				-

BNT 5 % = 0,0017

a a
 b b
 c c
 d d

BNT 1 % = 0,0026



Tabel 14. Analisis ragam lama waktu pembuatan butiran tiwul

Perlakuan	Ulangan			Total	Rata-rata
	I	II	III		
A	0,16	0,15	0,14	0,45	0,15
B	0,17	0,17	0,17	0,51	0,17
C	0,22	0,19	0,19	0,60	0,20
D	0,25	0,24	0,23	0,72	0,24
Total	0,80	0,75	0,73	2,28	0,76
Rata-rata	0,20	0,18	0,18	0,57	0,19

Perhitungan :

$$\begin{aligned}
 1. \text{ FK} &= Y^2 / r \times p \\
 &= (2,28)^2 / (3 \times 4) \\
 &= 0,4332
 \end{aligned}$$

$$\begin{aligned}
 2. \text{ JK Total} &= \sum_i \sum_j (Y_{ij} - \bar{Y}_{..})^2 - \text{FK} \\
 &= (0,16)^2 + (0,15)^2 + (0,14)^2 + \dots + (0,23)^2 - 0,4332 \\
 &= 0,4480 - 0,4332 \\
 &= 0,0148
 \end{aligned}$$

$$\begin{aligned}
 3. \text{ JK Kelompok} &= p \sum_j (\bar{Y}_{.j} - \bar{Y}_{..})^2 - \text{FK} \\
 &= (0,80^2 + 0,75^2 + 0,73^2) / 4 - 0,4332 \\
 &= 0,4338 - 0,4332 \\
 &= 0,0006
 \end{aligned}$$

$$\begin{aligned}
 4. \text{ JK Perlakuan} &= r \sum_i (\bar{Y}_{i.} - \bar{Y}_{..})^2 - \text{FK} \\
 &= (0,45^2 + 0,51^2 + 0,60^2 + 0,72^2) / 3 - 0,4332 \\
 &= 0,4470 - 0,4332 \\
 &= 0,0138
 \end{aligned}$$

$$\begin{aligned}
 4. \text{ JK G Perc.} &= \text{JK total} - \text{JK kelompok} - \text{JK perlakuan} \\
 &= 0,148 - 0,0006 - 0,0138 \\
 &= 0,0004
 \end{aligned}$$

$$\begin{aligned}
 5. \text{ KT kelompok} &= \text{JK}_k / (p - 1) \\
 &= 0,0006 / 3 = 0,0002
 \end{aligned}$$

$$\begin{aligned}
 6. \text{ KT perlakuan} &= JK_P / (r - 1) \\
 &= 0,0138 / 2 \\
 &= 0,0069 \\
 7. \text{ KT G Perc.} &= JK_G / (r - 1) (p - 1) = 0,0004 / 6 \\
 &= 0,00006
 \end{aligned}$$

Dari perhitungan di atas di dapatkan tabel analisis ragam :

Sumber keseragaman	db	JK	KT	Fhitung	Ftabel	
					0,05	0,01
Kelompok	2	0,0006	0,0002	3,33	5,14	10,92
Perlakuan	3	0,0138	0,0069	115	4,76	9,78
Galat percobaan	6	0,0004	0,00006			
Total	11	0,0148				

$$\begin{aligned}
 KK &= \frac{S}{Y} \times 100\% = \frac{\sqrt{KT \text{ G Percobaan}}}{Y} \times 100\% \\
 &= \frac{\sqrt{0,00006}}{0,19} \times 100\% = 4,07\%
 \end{aligned}$$

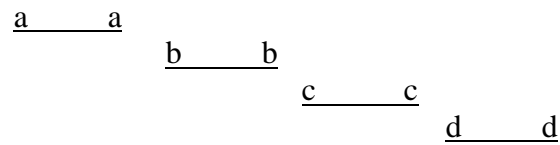
Beda Nyata Terkecil :

$$\begin{aligned}
 \text{BNT (0,05)} &= t^{(0,05)/2}(6) \times \sqrt{(2 \times 0,00006)/4} \\
 &= 2,447 \times 0,0054 \\
 &= 0,013
 \end{aligned}$$

$$\begin{aligned}
 \text{BNT (0,01)} &= t^{(0,01)/2}(6) \times \sqrt{(2 \times 0,00006)/4} \\
 &= 3,707 \times 0,0054 \\
 &= 0,020
 \end{aligned}$$

Perlakuan dan nilai tengah	Perlakuan dan nilai tengah			
	(A)	(B)	(C)	(D)
	0,15	0,17	0,20	0,24
(A) 0,15	-	0,02	0,05	0,09
(B) 0,17		-	0,03	0,07
(C) 0,20			-	0,04
(D) 0,24				-

BNT 5 % = 0,013



BNT 1 % = 0,020



Tabel 15. Analisis ragam kapasitas kerja mesin

Perlakuan	Ulangan			Total	Rata-rata
	I	II	III		
A	12,50	13,33	14,28	40,11	13,37
B	17,64	17,64	17,64	52,92	17,64
C	18,18	21,05	21,05	60,28	20,09
D	20,00	20,83	21,73	62,56	20,85
Total	68,32	72,85	74,70	215,87	71,95
Rata-rata	17,08	18,21	18,67	53,96	17,98

Perhitungan :

$$\begin{aligned}
 1. \text{ FK} &= Y^2 / r \times p \\
 &= (215,87)^2 / (3 \times 4) \\
 &= 3883,32
 \end{aligned}$$

$$\begin{aligned}
 2. \text{ JK Total} &= \sum_i \sum_j (Y_{ij} - \bar{Y}_{..})^2 - \text{FK} \\
 &= (12,50)^2 + (13,33)^2 + (14,28)^2 + \dots + (17,64)^2 - 3883,32 \\
 &= 3994,16 - 3883,32 \\
 &= 110,84
 \end{aligned}$$

$$\begin{aligned}
 3. \text{ JK Kelompok} &= p \sum_j (\bar{Y}_{.j} - \bar{Y}_{..})^2 - \text{FK} \\
 &= (68,32^2 + 72,85^2 + 74,70^2) / 4 - 3883,32 \\
 &= 3888,70 - 3883,32 \\
 &= 5,38
 \end{aligned}$$

$$\begin{aligned}
 4. \text{ JK Perlakuan} &= r \sum_i (\bar{Y}_{i.} - \bar{Y}_{..})^2 - \text{FK} \\
 &= (40,11^2 + 52,92^2 + 60,28^2 + 62,56^2) / 3 - 3883,32 \\
 &= 3985,59 - 3883,32 \\
 &= 102,27
 \end{aligned}$$

$$\begin{aligned}
 4. \text{ JK G Perc.} &= \text{JK total} - \text{JK kelompok} - \text{JK perlakuan} \\
 &= 110,84 - 5,38 - 102,27 \\
 &= 3,19
 \end{aligned}$$

$$\begin{aligned}
 5. \text{ KT kelompok} &= JK_K / (p - 1) \\
 &= 5,38 / 3 \\
 &= 1,79 \\
 6. \text{ KT perlakuan} &= JK_P / (r - 1) \\
 &= 102,27 / 2 \\
 &= 51,135 \\
 7. \text{ KT G Perc.} &= JK_G / (r - 1) (p - 1) = 3,19 / 6 \\
 &= 0,53
 \end{aligned}$$

Dari perhitungan di atas di dapatkan tabel analisis ragam :

Sumber keseragaman	db	JK	KT	Fhitung	Ftabel	
					0,05	0,01
Kelompok	2	5,38	1,79	3,37	5,14	10,92
Perlakuan	3	102,27	51,13	96,47	4,76	9,78
Galat percobaan	6	3,19	0,53			
Total	11	110,84				

$$KK = \frac{S}{Y} \times 100\% = \frac{\sqrt{KT \text{ G Percobaan}}}{Y} \times 100\% = \frac{\sqrt{0,53}}{17,98} \times 100\% = 4\%$$

Beda Nyata Terkecil :

$$\begin{aligned}
 \text{BNT (0,05)} &= t^{(0,05)/2}(6) \times \sqrt{(2 \times 0,53)/4} \\
 &= 2,447 \times 0,5147 \\
 &= 1,259
 \end{aligned}$$

$$\begin{aligned}
 \text{BNT (0,01)} &= t^{(0,01)/2}(6) \times \sqrt{(2 \times 0,53)/4} \\
 &= 3,707 \times 0,5147 \\
 &= 1,907
 \end{aligned}$$

Perlakuan dan nilai tengah	Perlakuan dan nilai tengah			
	(A)	(B)	(C)	(D)
	13,37	17,64	20,09	20,85
(A) 13,37	-	4,27	6,72	7,48
(B) 17,64		-	2,45	3,21
(C) 20,09			-	0,76
(D) 20,85				-

BNT 5 % = 1,259

a a
 b b
 c c
 d d

BNT 1 % = 1,907

a a
 b b
 c c
 d d

Tabel 16. Analisis ragam hasil produksi butiran tiwul

Perlakuan	Ulangan			Total	Rata-rata
	I	II	III		
A	2,63	2,75	2,75	8,13	2,71
B	3,54	3,72	3,75	11,01	3,67
C	4,49	4,70	4,77	13,96	4,65
D	5,32	5,52	5,58	16,42	5,47
Total	15,98	16,69	16,85	49,52	16,50
Rata-rata	3,99	4,17	4,21	12,38	4,12

Perhitungan :

$$\begin{aligned}
 1. \text{ FK} &= Y^2 / r \times p \\
 &= (49,52)^2 / (3 \times 4) \\
 &= 204,35
 \end{aligned}$$

$$\begin{aligned}
 2. \text{ JK Total} &= \sum_i \sum_j (Y_{ij} - \bar{Y}_{..})^2 - \text{FK} \\
 &= (2,63)^2 + (2,75)^2 + (2,75)^2 + \dots + (5,58)^2 - 204,35 \\
 &= 217,38 - 204,35 \\
 &= 13,03
 \end{aligned}$$

$$\begin{aligned}
 3. \text{ JK Kelompok} &= p \sum_j (\bar{Y}_{.j} - \bar{Y}_{..})^2 - \text{FK} \\
 &= (15,98^2 + 16,69^2 + 16,85^2) / 4 - 204,35 \\
 &= 205,45 - 204,35 \\
 &= 0,10
 \end{aligned}$$

$$\begin{aligned}
 4. \text{ JK Perlakuan} &= r \sum_i (\bar{Y}_{i.} - \bar{Y}_{..})^2 - \text{FK} \\
 &= (8,13^2 + 11,01^2 + 13,96^2 + 16,42^2) / 3 - 204,35 \\
 &= 217,27 - 204,35 \\
 &= 12,92
 \end{aligned}$$

$$\begin{aligned}
 4. \text{ JK G Perc.} &= \text{JK total} - \text{JK kelompok} - \text{JK perlakuan} \\
 &= 13,03 - 0,10 - 12,92 \\
 &= 0,01 \\
 5. \text{ KT kelompok} &= \text{JK}_K / (p - 1) \\
 &= 0,10 / 3 \\
 &= 0,033 \\
 6. \text{ KT perlakuan} &= \text{JK}_P / (r - 1) \\
 &= 12,92 / 2 \\
 &= 6,46 \\
 7. \text{ KT G Perc.} &= \text{JK}_G / (r - 1) (p - 1) = 0,01 / 6 \\
 &= 0,00167
 \end{aligned}$$

Dari perhitungan di atas di dapatkan tabel analisis ragam :

Sumber keseragaman	db	JK	KT	Fhitung	Ftabel	
					0,05	0,01
Kelompok	2	0,10	0,033	19,76	5,14	10,92
Perlakuan	3	12,92	6,46	3868,26	4,76	9,78
Galat percobaan	6	0,01	0,00167			
Total	11	13,03				

$$\text{KK} = \frac{S}{Y} \times 100\% = \frac{\sqrt{\text{KT G Percobaan}}}{Y} \times 100\% = \frac{\sqrt{0,00167}}{4,12} \times 100\% = 0,99\%$$

Beda Nyata Terkecil :

$$\begin{aligned}
 \text{BNT (0,05)} &= t^{(0,05)/2}(6) \times \sqrt{(2 \times 0,00167)/4} \\
 &= 2,447 \times 0,0288 \\
 &= 0,0704
 \end{aligned}$$

$$\begin{aligned}
 \text{BNT (0,01)} &= t^{(0,01)/2}(6) \times \sqrt{(2 \times 0,00167)/4} \\
 &= 3,707 \times 0,0288 \\
 &= 0,1085
 \end{aligned}$$

Perlakuan dan nilai tengah	Perlakuan dan nilai tengah			
	(A)	(B)	(C)	(D)
(A) 13,37	13,37	17,64	20,09	20,85
(B) 17,64	-	4,27	6,72	7,48
(C) 20,09	-	-	2,45	3,21
(D) 20,85	-	-	-	0,76
				-

BNT 5 % = 0,0704

a a

b b

c c

d d

BNT 1 % = 0,1085

a a

b b

c c

d d