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Heterosis for yield related traits, fiber quality traits and biochemical parameter in cotton [*Gossypium hirsutum* (L.)]

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Abstract
The present experiment was carried out during *kharif* 2019 and 2020 using thirteen different genotypes of cotton at Main Cotton Research Station, Navsari Agricultural University, Surat. Among them five cross combinations viz., GCot 16 BG II x GTHV 02/45, BC 68-2 BG II x GTHV 02/45, GCot 10 BG II x GSHV 95/216, GCot 16 BG II x SCS 1062 and GCot 16 BG II x GSHV 172 manifested significant and positive heterobeltiosis as well as significant standard heterosis over check GCot Hy-10 BG II. It also manifested significant standard heterosis in desired direction for one or more yield attributing characters like bolls per plant and seed index. In case of fiber characters, the maximum value of standard heterosis was observed by the cross GCot 10 BG II x SCS 1062 for ginning outturn, BC 68-2 BG II x GSHV 172 for fiber length, GCot 10 BG II x TCH 1705 for fiber strength and GCot 10 BG II x GSHV 213 for fiber fineness in desired direction. For biochemical parameter, the cross BC 68-2 BG II x GSHV 213 for gossypol content, GCot 16 BG II x GTHV 02/45 for protein content, GCot 16 BG II x SCS 1062 for phenol content and BC 68-2 BG II x GSHV 95/216 for proline content was observed significant standard heterosis in desired direction.

Keywords: Cotton, heterosis, heterobeltiosis, standard heterosis, yield contributing traits, line x tester, gene action

Introduction
Cotton is an important commercial cash crop in the country, being the principal raw material for textile industry and popularly known as the "White Gold". Cotton is one of the few often cross-pollinated crops which is accessible to development of homozygous genotypes as varieties and at the same time amenable for commercial exploitation of heterosis by exploitation of additive as well as non-additive genetic variance. Cotton is one of the few often cross pollinated crop which is accessible to development of homozygous genotypes as varieties and at the same time amenable for commercial exploitation of heterosis by exploitation of additive as well as non-additive genetic variance. Hybrids have occupied nearly 90% area of cotton cultivated in India. There is a continuous need to develop more potential hybrids and adopt novel approaches for improving hybrid performance. Heterosis in cotton has been known since 1970. India was the first country to commercially exploit heterosis in cotton. Cotton is one of the few crops which are accessible to the development of genotypes as varieties and at the same time amenable for commercial exploitation of heterosis. Heterosis is the phenomenon in which the F1 of two genetically dissimilar parents show increased vigour for various characters over the mid parent (relative heterosis) or better parent (heterobeltiosis) or the standard check (standard heterosis). The magnitude of heterosis provides a basis for genetic diversity of the parents and a guide to the choice of parents in developing superior F1's so as to exploit hybrid vigour. In addition, if heterosis is due to epistatic gene action, particularly of additive x additive type, it would be possible to fix alleles at the interacting loci to preserve the heterotic effect. The heterotic hybrids can also produce desirable transgressive segregant in advanced generations. In order to formulate an efficient breeding approach for improving cotton through heterosis breeding, an understanding of the nature and magnitude of gene action controlling yield characters is essential. The magnitude of heterosis depends on the choice of appropriate parental lines.

Materials and Methods

The present experiment was carried out during *kharif* 2019 and 2020 using thirteen different genotypes of cotton at Main Cotton Research Station, Navsari Agricultural University, Surat. The experimental materials comprised of thirteen diverse genotypes of cotton including three Bt female parents *viz*., G.Cot 10 BG II, G.Cot 16 BG II, BC 68-2 BG II as well as ten male parents viz., GSHV 95/216, GTHV 02/45, GJHV 152, H 1452, BWR 25, GSHV 172, SCS 1062, GSHV 213, BB-1, TCH 1705 and their 30 crosses (line x tester) along with G.Cot Hy-10 BG II as standard check Thirty hybrids were obtained during kharif, 2019 from Main Cotton Research Station, Navsari Agricultural University, Surat using three females and ten diverse pollinators in a line x tester mating design. The hybrid (F_1) seeds were produced by Dock's (1934) method. One plant of each parent was also selfed to obtain selfed parental seeds used for final evaluation. All the F_1's and selfed seeds of parents were stored properly in seed packets for sowing in the next season kharif 2020. Five random competitive representative plants, excluding border plant, of each genotype in each replication were selected to record the observation for days to 50% flowering, boll weight (g), seed cotton yield per plant (g), ginning outturn (%), seed index (g), fiber length (mm), fiber strength (g/tex), fiber fineness (mv), oil content (%), gossypol content (mg/100 g), protein content (mg/g), phenol content (%) and proline content (mg/g).

Results and Discussion

The analysis of variance was presented in Table 1. The analysis of variance showed highly significant differences among the genotypes for all the traits revealed that the considerable amount of variability was observed among experimental material.

The estimation of heterosis over better parent (heterobeltosis) and over standard check (standard heterosis) for different character is presented in Table 2.

Days to 50% flowering

Heterobeltiosis for days to 50% flowering ranged from -7.56 (BC 68-2 BG II x BWR 25) to 8.64 percent (BC 68-2 BG II x GSHV 213). The highest desirable standard heterosis was observed in the cross BC 68-2 BG II x BWR 25 (-5.29%).

Bolls per plant

Heterobeltiosis ranged from -10.61 (BC 68-2 BG II x BWR 25) to 145.51 percent (BC 68-2 BG II x GSHV 95/216) for bolls per plant. Hybrid GCot 16 BG II x GTHV 02/45 (97.64%) exhibited the highest desirable heterosis. Significant and positive standard heterosis observed in eleven crosses for bolls per plant.

Boll weight (g)

The range of better parent heterosis was from -33.86 (BC 68-2 BG II x GSHV 172) to 36.62 percent (G Cot 10 BG II x GSHV 95/216). Hybrid G Cot 10 BG II x GSHV 95/216 (36.62%) exhibited the highest desirable heterosis. The range of standard heterosis was from -19.25 (BC 68-2 BG II x GSHV 172) to 45.29 percent (BC 68-2 BG II x BWR 25). For heterosis over standard check twenty five crosses showed significant and positive value for boll weight.

Seed cotton yield per plant (g)

The range of heterobeltiosis for this important economic character was from -13.07 (BC 68-2 BG II x GSHV 172) to 187.08 percent (GCot 16 BG II x GTHV 02/45). The quantum of standard heterosis was from -31.91 (BC 68-2 BG II x GSHV 172) to 125.12 percent (GCot 16 BG II x GTHV 02/45). Among thirty crosses, twenty-two hybrids reported significant and positive standard heterosis.

Ginning outturn (%)

The heterobeltiosis for ginning percentage ranged from -11.67 (BC 68-2 BG II x BB-1) to 19.50% (GCot 16 BG II x TCH 1705).The standard heterosis ranged from -10.76 (GCot 16 BG II x H 1452) to 6.45% (GCot 10 BG II x SCS 1062). Hybrid GCot 10 BG II x SCS 1062 (6.45%) exhibited the highest desirable heterosis.

Seed index (g)

The heterobeltiosis ranged from -24.17 (G Cot 16 BG II x BWR 25) to 22.09% (G Cot 10 BG II x GTHV 02/45). The range of standard heterosis was from -7.91 (GCot 10 BG II x H 1452) to 27.14% (BC 68-2 BG II x GSHV 95/216).

Fiber length (mm)

The heterobeltiosis ranged from -13.33 (GCot 16 BG II x GSHV 172) to 19.38% (BC 68-2 BG II x GSHV 172. The range of standard heterosis was from -6.47 (G Cot 16 BG II x GSHV 172) to 10.79% (BC 68-2 BG II x GSHV 172).

Fiber strength (g/tex)

The heterobeltiosis for fiber strength range between –14.95 (GCot 16 BG II x GSHV 172) to 16.92% (BC 68-2 BG II x BB-1). The standard heterosis lied between -8.24 (GCot 16 BG II x GSHV 172) and 10.04% (GCot 10 BG II x TCH 1705).

Oil content (%)

The range of heterobeltiosis was from -5.84 (GCot 16 BG II x H 1452) to 6.96% (BC 68-2 BG II x H 1452). Standard heterosis for oil percentage ranged from -5.86 (GCot 16 BG II x H 1452) to 6.94% (BC 68-2 BG II x H 1452). Out of the 30 crosses the only one cross BC 68-2 BG II x H 1452 showed significant and positive for both heterobeltiosis (6.96%) and standard heterosis (6.94%).

Gossypol content (mg/100 g)

Heterobeltiosis for gossypol content ranged from -32.24 (BC 68-2 BG II x GSHV 213) to 54.09% (GCot 16 BG II x TCH 1705). For standard heterosis, the range was observed from -15.61 (BC 68-2 BG II x GSHV 213) to 42.53% (GCot 10 BG II x GSHV 95/216).

Protein content (mg/g)

The range of heterobeltiosis was from -46.60 (GCot 16 BG II x SCS 1062) to 3.14% (BC 68-2 BG II x BB-1). Standard heterosis for protein content ranged from-35.21 (GCot 10 BG II x GJHV 152) to 22.23% (GCot 16 BG II x GTHV 02/45).

Phenol content (%)

The range of heterobeltiosis was from -31.97 (BC 68-2 BG II x TCH 1705) to 57.85% (G Cot 16 BG II x SCS 1062) for phenol content. The cross BC 68-2 BG II x TCH 1705 (57.85%) showed the highest heterobeltiosis. The standard heterosis ranged from -27.19 (BC 68-2 BG II x TCH 1705) to 67.54% (GCot 16 BG II x SCS 1062).

Proline content (mg/g)

The range of heterobeltiosis from -97.84 (GCot 10 BG II x GSHV 213) to 41.93% (BC 68-2 BG II x GSHV 95/216) for phenol content. The cross BC 68-2 BG II x GSHV 95/216 (41.93%) showed the highest heterobeltiosis.

Table 1: Analysis of variance (mean sum of square) for experimental design for different traits in *G. hirsutum* L.

Source of variation	d.f.	Days to 50% flowering	Bolls per plant	Boll weight (g)	Seed cotton yield per plant (g)	Ginning outturn (%)	Seed index (g)	Fibre length (mm)	Fibre strength (g/tex)	Fibre fineness (mv)	Oil content (%)	Gossypol content (mg/100 g)	Protein content (mg/g)	Phenol content (%)	Proline content (mg/g)
Replications	2	4.94	30.87	0.01	296.52	0.70	0.98	1.41	8.12**	1.36**	1.77**	0.46	2.96*	0.00	0.00
Treatments	42	12.29**	393.94**	0.81**	6159.04**	13.89**	2.82**	7.07**	6.68**	0.43**	0.72**	455.29**	35.74**	0.01**	0.55**
Parents	12	14.71**	68.77**	0.70**	675.34**	23.12**	4.32**	7.61**	6.39**	0.66**	0.86**	309.95**	42.74**	0.00	0.50**
Lines	2	3.44	142.01**	0.49**	830.18**	8.11**	4.89**	18.93**	14.17**	0.27	0.07	479.84**	6.60**	0.00	0.14**
Testers	9	18.52**	50.05**	0.76**	667.36**	20.96**	4.61**	4.09**	4.07**	0.74**	1.03**	283.05**	40.52**	0.00	0.53**
Lines *vs* Testers	1	2.97	90.76*	0.52**	437.47	72.60**	0.49	16.63**	11.76**	0.71	0.87	212.22**	134.94**	0.00	0.94**
Parents *vs* Hybrids	1	71.00**	5508.99**	6.19**	118599.13**	52.40**	2.46*	112.38**	54.80**	0.10	0.94	1057.43**	31.92**	0.02**	0.03
Crosses	29	9.26**	352.11**	0.67**	4550.90**	8.74**	2.22**	3.22**	5.35**	0.34	0.66*	494.67**	32.97**	0.01**	0.59**
Line effect	2	0.03	59.92	0.84	772.95	45.63**	1.24	4.12	13.12	0.10	0.77	907.45	1.55	0.00	0.02
Tester effect	9	12.86	587.40	0.69	7129.95	8.61	4.18	2.69	5.78	0.16**	0.34	460.35	37.45	0.01	0.56
Line x Tester effect	18	8.49**	266.93**	0.64**	3681.16**	4.70**	1.35**	3.39**	4.27**	0.47**	0.81**	465.97**	34.22**	0.01**	0.67**
Error	84	2.44	13.69	0.02	164.74	0.69	0.38	0.67	0.46	0.23	0.35	1.35	0.73	0.00	0.01

* and ** indicates significance at 5% and 1% levels of probability, respectively

Table 2: Percent heterobeltiosis (H_1) and standard heterosis (H_2) for days to 50% flowering, Sympodia per plant, bolls per plant, boll weight and seed cotton yield per plant in *G. hirsutum*L.

Sr. No.	Crosses	Days to 50% flowering		Bolls per plant		Boll weight (g)		Seed cotton yield per plant (g)	
		H_1 (%)	H_2 (%)	H_1 (%)	H_2 (%)	H_1 (%)	H_2 (%)	H_1 (%)	H_2 (%)
1	G Cot 10 BG II x GSHV 95/216	-2.82	1.78	56.89**	25.30**	36.62**	35.50**	113.98**	69.58**
2	G Cot 10 BG II x GTHV 02/45	-1.13	3.55	39.13**	18.81*	5.49	4.62	56.29**	23.86**
3	G Cot 10 BG II x GJHV 152	-2.30	0.59	29.14**	3.14	-12.54**	13.05**	47.15**	16.62*
4	G Cot 10 BG II x H 1452	-2.31	0.00	60.85**	28.46**	-1.42	2.51	67.05**	32.39**
5	G Cot 10 BG II x GSHV 172	-1.75	-0.59	27.94**	2.18	12.34**	15.24**	48.47**	17.66*
6	G Cot 10 BG II x SCS 1062	0.60	-0.59	21.53*	-2.95	15.81**	22.48**	43.97**	18.84*
7	G Cot 10 BG II x GSHV 213	1.23	-2.96	26.87**	1.32	10.30**	27.87**	53.67**	29.81**
8	G Cot 10 BG II x BB-1	-4.52*	0.00	20.92*	-3.43	4.93	31.51**	53.15**	26.92**
9	G Cot 10 BG II x BWR 25	-2.82	1.78**	27.11**	1.51	7.58*	14.91**	47.47**	16.88*
10	G Cot 10 BG II x TCH 1705	-1.69	2.96**	67.50**	33.77**	-0.31	-1.13	66.91**	32.28**
11	G Cot 16 BG II x GSHV 95/216	-3.51	-2.37	61.41**	-14.20*	7.56*	28.52**	120.90**	10.36
12	G Cot 16 BG II x GTHV 02/45	0.58	1.78**	131.45**	97.64**	-4.47	14.15**	187.08**	125.12**
13	G Cot 16 BG II x GJHV 152	-1.75	-0.59	92.93**	-11.16	6.75*	37.99**	105.72**	22.49**
14	G Cot 16 BG II x H 1452	0.58	1.78**	1.43	-32.83**	6.53*	27.29**	23.99*	-14.53
15	G Cot 16 BG II x GSHV 172	-0.58	0.59**	63.48**	24.67**	9.02**	30.27**	106.53**	61.78**
16	G Cot 16 BG II x SCS 1062	3.59	2.37**	56.30**	21.74*	13.47**	35.59**	100.18**	65.23**
17	G Cot 16 BG II x GSHV 213	7.41**	2.96**	90.45**	38.11**	-12.37**	4.71	71.12**	44.56**
18	G Cot 16 BG II x BB-1	-1.75	-0.59	9.76	-27.37**	7.24*	34.39**	17.79	-2.38
19	G Cot 16 BG II x BWR 25	-5.85**	-4.73*	40.14**	-2.99	-0.13	19.34**	56.33**	15.63*
20	G Cot 16 BG II x TCH 1705	3.51	4.73*	-4.09	-30.54**	15.57**	38.10**	48.63**	-3.86
21	BC 68-2 BG II x GSHV 95/216	2.33	4.14*	145.51**	30.50**	0.41	22.58**	146.68**	59.60**
22	BC 68-2 BG II x GTHV 02/45	6.98**	8.88**	107.63**	77.30**	-1.56	20.17**	171.67**	113.04**
23	BC 68-2 BG II x GJHV 152	-4.07*	-2.37	22.45	-35.00**	6.36*	37.49**	38.24**	-10.56
24	BC 68-2 BG II x H 1452	-3.49	-1.78	63.01**	7.95	-11.34**	8.24*	69.69**	16.97*
25	BC 68-2 BG II x GSHV 172	0.58	1.78	10.93	-15.40*	-33.86**	-19.25**	-13.07	-31.91**
26	BC 68-2 BG II x SCS 1062	-3.59	-4.73*	53.14**	19.28*	-2.50**	19.03**	72.23**	42.16**
27	BC 68-2 BG II x GSHV 213	8.64**	4.14*	15.65	-16.13*	9.67**	33.88**	33.05**	12.39
28	BC 68-2 BG II x BB-1	-1.16	0.59	33.75**	-11.49	8.86**	36.43**	45.88**	20.90*
29	BC 68-2 BG II x BWR 25	-7.56**	-5.92**	-10.61	-38.12**	19.02**	45.30**	21.70*	-9.99
30	BC 68-2 BG II x TCH 1705	-1.16	0.59	50.55**	9.03	-7.75**	12.62**	89.48**	22.59**
SE (d) ±		1.31	1.31	3.20	3.20	0.13	0.13	10.94	10.94
CD @ 5%		2.63	2.63	6.41	6.41	0.27	0.27	21.90	21.90

Table 3: Percent heterobeltiosis (H_1) and standard heterosis (H_2) for Ginning outturn (%), Seed index (g), Fiber length (mm), Fiber strength (g/tex) and Fiber fineness (mv) in *G. hirsutum* L.

Sr. No.	Crosses	Ginning outturn (%)		Seed index (g)		Fiber length (mm)		Fiber strength (g/tex)		Fiber fineness (mv)	
		H_1 (%)	H_2 (%)	H_1 (%)	H_2 (%)	H_1 (%)	H_2 (%)	H_1 (%)	H_2 (%)	H_1 (%)	H_2 (%)
1	G Cot 10 BGII x GSHV 95/216	11.61**	3.01	13.74**	26.80**	10.12**	1.80	8.21**	3.94*	16.67*	19.51*
2	G Cot 10 BGII x GTHV 02/45	-3.86**	3.73*	22.09**	20.59**	10.89**	2.52	0.75	-3.23	20.59*	0.00
3	G Cot 10 BGII x GJHV 152	0.93	-1.81	3.53	11.10*	8.56**	0.36	8.96**	4.66*	5.26	-2.44
4	G Cot 10 BGII x H 1452	6.15**	0.59	0.74	-7.91	7.39**	-0.72	4.10*	0.00	2.44	2.44
5	G Cot 10 BGII x GSHV 172	2.83	0.72	-0.08	1.62	5.81*	-1.80	4.36*	2.87	2.38	4.88
6	G Cot 10 BGII x SCS 1062	15.34**	6.45**	-5.91	10.46*	13.23**	4.68*	13.06**	8.60**	2.38	4.88
7	G Cot 10 BGII x GSHV 213	5.82**	3.61*	3.78	7.36	8.24**	3.96	4.85*	0.72	0.00	-4.88
8	G Cot 10 BGII x BB-1	-7.20**	-0.44	-22.86**	9.95	16.73**	7.91**	5.22**	1.08	-17.07*	-17.07*
9	G Cot 10 BGII x BWR 25	4.87**	-0.84	13.70*	4.47	-3.93	-3.24	-7.37**	-5.38**	-7.14	-4.88
10	G Cot 10 BGII x TCH 1705	5.94**	-2.23	-3.21	3.96	11.67**	3.24	14.55**	10.04**	7.14	9.76
11	G Cot 16 BGII x GSHV 95/216	18.33**	5.42**	-14.60**	4.00	-6.33**	1.08	-2.99	4.66*	12.82	7.32
12	G Cot 16 BGII x GTHV 02/45	-8.63**	-1.42	1.68	23.82**	-7.67**	-0.36	-7.97**	-0.72	8.82	-9.76
13	G Cot 16 BGII x GJHV 152	-0.13	-2.84	0.07	21.86**	-4.33*	3.24	-6.31**	1.08	-5.26	-12.20
14	G Cot 16 BGII x H 1452	-5.83**	-10.76**	-12.68**	6.34	-8.00**	-0.72	-9.63**	-2.51	2.56	-2.44
15	G Cot 16 BGII x GSHV 172	-3.70*	-5.68**	-6.85	13.44*	-13.33**	-6.47**	-14.95**	-8.24**	-2.56	-7.32
16	G Cot 16 BGII x SCS 1062	11.46**	0.56	1.50	23.61**	-8.00**	-0.72	-9.30**	-2.15	-2.56	-7.32
17	G Cot 16 BGII x GSHV 213	4.75**	2.57	-11.28*	8.04	-12.33**	-5.40*	-12.62**	-5.73**	15.38	9.76
18	G Cot 16 BGII x BB-1	-11.15**	-4.68**	-11.82**	25.69**	-7.33**	0.00	-10.96**	-3.94*	7.69	2.44
19	G Cot 16 BGII x BWR 25	2.90**	-2.70	-24.17**	-7.66	-8.00**	-0.72	-8.31**	-1.08	10.26	4.88
20	G Cot 16 BGII x TCH 1705	19.50**	1.18	-0.91	20.67**	-5.33**	2.16	-9.97**	-2.87*	5.13	0.00
21	BC 68-2 BGII x GSHV 95/216	2.88	-8.34**	8.81	27.14**	7.00**	-1.08	11.11**	3.94	0.00	-12.20
22	BC 68-2 BGII x GTHV 02/45	-8.86**	-1.67	-9.76*	5.44	7.42**	-1.08	3.45	-3.23	29.41	7.32
23	BC 68-2 BGII x GJHV 152	-6.57**	-9.11**	6.95	24.97**	12.50**	3.60	7.52**	2.51	25.00*	9.76
24	BC 68-2 BGII x H 1452	2.99	-2.41	-18.64**	-4.93	5.08*	-3.24	4.23*	-2.87	0.00	-12.20
25	BC 68-2 BGII x GSHV 172	-5.90**	-7.84**	-20.68**	-7.32	19.38**	10.79**	11.27**	9.68**	8.33	-4.88
26	BC 68-2 BGII x SCS 1062	15.07**	3.81*	-3.62	13.14*	5.47*	-2.88	8.46**	1.08	8.33	-4.88
27	BC 68-2 BGII x GSHV 213	-5.63**	-7.59**	-5.93	9.91	3.00	-1.08	1.13	-3.58*	22.22*	7.32
28	BC 68-2 BGII x BB-1	-11.67**	-5.24**	-13.28**	23.61**	11.72**	2.88	16.92**	8.96**	19.44*	4.88
29	BC 68-2 BGII x BWR 25	-4.59*	-9.78**	-15.11**	-0.81	-5.71**	-5.04*	-6.32**	-4.30*	11.11	-2.44
30	BC 68-2 BGII x TCH 1705	8.52**	-8.72**	0.36	17.27**	10.16**	1.44	6.34**	2.15	13.89	0.00
SE (d) ±		0.57	0.57	0.47	0.47	0.64	0.64	0.61	0.61	0.39	0.39
CD @ 5%		1.14	1.14	0.93	0.93	1.29	1.29	1.21	1.21	0.79	0.79

It was concluded that analysis of heterosis showed significant heterobeltiosis and standard heterosis for seed cotton yield, majority of the yield components and fiber quality parameters suggested that there is a good scope of exploiting heterosis commercially. Five cross combinations viz., GCot 16 BG II x GTHV 02/45, BC 68-2 BG II x GTHV 02/45, GCot 10 BG II x GSHV 95/216, GCot 16 BG II x SCS 1062 and GCot 16 BG II x GSHV 172 manifested significant and positive heterobeltiosis as well as significant standard heterosis over check GCot Hy-10 BG II. In case of fiber characters, the maximum value of standard heterosis was observed by the cross GCot 10 BG II x SCS 1062 for ginning outturn, BC 68-2 BG II x GSHV 172 for fiber length, GCot 10 BG II x TCH 1705 for fiber strength and GCot 10 BG II x GSHV 213 for fiber fineness in desired direction. For biochemical parameter, the cross BC 68-2 BG II x GSHV 213 for gossypol content, GCot 16 BG II x GTHV 02/45 for protein content, GCot 16 BG II x SCS 1062 for phenol content and BC 68-2 BG II x GSHV 95/216 for proline content was observed significant standard heterosis in desired direction.

Authorship Contribution Statement

Study conception and design: Nilesh Parmar**,** Dr. G.O. Faldu; data collection: Nilesh Parmar; Biochemical parameter carried by Nilesh Parmar and Dr. H.R. Ramani; analysis and interpretation of results: Dr. G.O. Faldu, Dr. A.O. Sanghani, Dr. Ritaben R. Patel; draft manuscript preparation: Dr. A.O. Sanghani. All authors reviewed the results and approved the final version of the manuscript.

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