Journal of Reliability and Statistical Studies; ISSN (Print): 0974-8024, (Online):2229-5666
Vol. 6, Issue 2 (2013): 01-15

ACCEPTANCE SAMPLING PLAN BASED ON TRUNCATED LIFE TESTS FOR COMPOUND RAYLEIGH DISTRIBUTION

Bhupendra Singh[1], K. K. Sharma and Dushyant Tyagi[2]
Department of Statistics
C. C. S. University, Meerut-250004, India
Email: [1]bhupendra.rana@gmail.com, [2]dushyanttyagi@its.edu.in

(Received January 24, 2013)

Abstract

In this paper, a reliability sampling plan is developed assuming that lifetimes of the test units follow compound Rayleigh distribution and the life test is terminated at a pre-fixed time. This type of sampling plan is used to save the test time in practical situations. The minimum sample size required for ensuring the specified mean life at specified consumer's confidence level has been determined. The operating characteristic curve values of the sampling plans are examined with varying ratio of the true mean life to the specified life. The minimum such mean ratios are also obtained to minimize the producer's risk at the specified level. For illustrative purpose, a numerical example has been discussed.

Key Words: Acceptance Sampling, Compound Rayleigh Distribution, Producer's Risk, Consumer's Risk, Operating Characteristic Curve, Truncated Life Test.

1. Introduction

Lifetime is an important quality characteristic of a product. In most of the life testing sampling plans, a common constraint is the duration of the total time spent on the test. Since life testing experiments are expected to be very time consuming, it is usual to terminate a life test by a pre-fixed time and record the number of failures till that time. The purpose of these tests is to set a confidence limit on the mean life. Once a confidence limit on the mean life is set, then it is desired to establish a specified mean life, say, μ_0 with at least a given confidence level P*. The decision to accept the specified mean life occurs if and only if the observed number of failures at the end of the pre-fixed time't' do not exceed a given acceptance number c. That is, if the number of failures exceeds c, one can terminate the test before the time t and reject the lot. Such a test is called the truncated life test [Tsai et al. (2006)]. The problem here is that of finding the smallest sample size necessary to achieve a certain mean life based on the truncated life test. Thus, the sampling plan consists of the number of items n put on test, the acceptance number c and the ratio t/μ_0 for a fixed P^*. Such a sampling plan is characterized by the triplet (n, c, t/μ_0) in the literature.
Acceptance sampling plans based on truncated life tests were developed by Gupta & Groll (1961) for gamma distribution; by Kantam & Rosaiah (1998) for half logistic distribution; by Kantam et al. (2001) for log-logistic distribution; by Baklizi and El Masri (2004) for Birnbaum–Saunders model; by Aslam and Shahbaz (2007) for Generalized Exponential distribution and by Khan and Islam (2010) for alpha distributed lifetimes.

The present study deals with the development of acceptance sampling plan assuming the life time distribution of the product as a compound Rayleigh distribution. The rest of this paper is organized as follows. Further we have introduced the compound Rayleigh distribution. In section 3, an acceptance sampling plan for the truncated life test based on the compound Rayleigh distribution is developed and its operating characteristics value and minimum ratio of the true mean to the specified mean at the specified level of producer's risk are analysed. In section 4, a numerical example has been given for highlighting the use of the theoretical developments. Some conclusions have been made in the final section.

2. Compound Rayleigh Distribution

The Rayleigh distribution has played an important role in modelling the lifetime of random phenomenon. It arises in many areas of applications, including reliability, life testing and survival analysis. Polovko (1968) noticed the importance of the Rayleigh distribution in electro vacuum devices. Bhattacharya and Tyagi (1990) used the Rayleigh distribution to model the survival time distribution of cancer patients in certain clinical studies. Mostert et al. (1998) studied Bayesian analysis of survival data using the Rayleigh model and the compound Rayleigh model. Raqab et al. (2002) discussed Bayesian prediction of the total time on test using doubly censored Rayleigh data. Tsai et al. (2006) developed Acceptance sampling based on truncated life tests for generalized Rayleigh distribution.

Let X denotes a random variable arising from a Rayleigh distribution with p.d.f.

$$f(t;\theta) = 2\theta t e^{-\theta t^2} \tag{1}$$

Where $t > 0$ is the lifetime, and $\theta > 0$.

The corresponding hazard function is

$$h(t) = 2\theta t, \qquad t > 0$$

The mean survival time and the cumulative distribution function of the Rayleigh model are given by

$$E(t) = \frac{1}{2}\sqrt{\frac{\pi}{\theta}} \tag{2}$$

$$F(t) = 1 - e^{-\frac{t^2}{\theta}} \tag{3}$$

In life testing experiments, it is expected that the environmental conditions can not be remained same during the testing time. Therefore, it seems logical to treat the parameters involved in the life time model as random variables. In view of this, if the parameter θ is itself a random variable, then the distribution of lifetime of each item is a compound Rayleigh distribution. The particular form of θ, which is considered here, is the gamma p.d.f.

$$g(\theta,\beta,\delta) = \frac{\beta^{\delta}\theta^{\delta-1}e^{-\beta\theta}}{\Gamma\delta} \qquad \theta,\beta,\delta > 0 \tag{4}$$

The parameters β and δ are scale and shape parameters, respectively. The resulting compound distribution has p.d.f.

$$f(t;\beta,\delta) = \int_0^{\infty} 2\theta t e^{-\theta t^2} \frac{\beta^{\delta}\theta^{\delta-1}e^{-\beta\theta}}{\Gamma\delta} d\theta$$

$$= 2\delta\beta^{\delta} t(\beta + t^2)^{-(\delta+1)} \tag{5}$$

The mean survival time and the cumulative distribution function of the compound Rayleigh model are given by

$$\mu = E(t) = \frac{\sqrt{\beta\pi}\,\Gamma(\delta-\frac{1}{2})}{2\Gamma\delta} \qquad (6)$$

And

$$F(t;\beta,\delta) = 1-\beta^{\delta}(\beta+t^2)^{-\delta}, \qquad t>0 \qquad (7)$$

3. Notations

n	Sample size
c	Acceptance number
d	Number of defectives
t	Termination time
δ	Shape parameter
β	Scale parameter
P*	Consumer's confidence level
p	Probability of failure before time t
P_a	Probability of acceptance of lot
μ_0	Specified mean life
α	Producer's risk

4. Design of the Proposed Sampling Plan

Our objective of this plan is to set a lower confidence limit on the product's mean lifetime, and we want to test whether the mean lifetime of the product is longer than our expectation. Suppose n items from the lot are to be tested for their mean life and μ_0 is the specified mean lifetime for each item. Then, according to the plan, the lot will be accepted if and only if the number of observed failures at the end of the pre-fixed time t_0 does not exceed a given number c; and the test will be terminated with the rejection of the lot if there are more than c failures occurred before time t_0, which implies that the true mean lifetime of the product is below the specified one. Let the termination time be a multiple of the specified life μ_0, i.e. $t_0 = a\mu_0$ for a specified multiplier 'a'. The sampling plan then consists of the following parameters: the number of units 'n', put on test, an acceptance number 'c', and a experiment time ratio 't/μ_0'.

In other words, we can say that the acceptance of the submitted lot depends on the following hypothesis, Ho: $\mu \geq \mu_0$ against the alternative hypothesis $H_1: \mu < \mu_0$. The consumer's risk (1-P*) is used as the level of significance of the test, where P* is the consumer's confidence level. The probability P* is a confidence level in the sense that the chance of rejecting a lot with $\mu < \mu_0$ is at least P*. Thus, for testing the above null hypothesis, first of all, we have to fix the consumer's risk, the probability of accepting a bad lot, not to exceed 1- P*. Here, a bad lot means that the lot with the true mean lifetime μ is below the specified mean lifetime μ_0.

Mathematically, for given P* (0 < P* < 1), the experiment time ratio t/μ_0 and an acceptance number c , we need to find the smallest positive integer 'n' so that we can assert that $\mu \geq \mu_0$ with confidence level of P* provided that the number of failures observed in time t does not exceed c .

If the lot size is assumed to be large enough, then, in accordance with the design of the proposed sampling plan, the required sample size, 'n' will be the smallest positive integer that satisfies the following inequality

$$\sum_{i=0}^{c} \binom{n}{i} {p_0}^i (1-p_0)^{n-i} \le (1-P^*) \tag{8}$$

Where $p_0 = F(t_0; \beta, \delta)$ is the probability that an item fails before time t_0 and from equation (7) it is given by

$$\begin{aligned} p_0 &= 1 - \beta^{\delta}(\beta + {t_0}^2)^{-\delta} \\ &= 1 - \frac{1}{(1+{t_0}^2/\beta)^{\delta}} \end{aligned} \tag{9}$$

From equation (6), we have

$$\begin{aligned} \mu &= \frac{\sqrt{\beta\pi}\,\Gamma(\delta - \frac{1}{2})}{2\Gamma\delta} \\ \Rightarrow \sqrt{\beta} &= \frac{2\mu\Gamma\delta}{\sqrt{\pi}\Gamma(\delta - \frac{1}{2})} \end{aligned} \tag{10}$$

After putting the value of $\sqrt{\beta}$ from equation (10) and $t = a\mu_0$ in equation (9), one gets

$$p_0 = 1 - \frac{1}{1 + \left(\frac{a\sqrt{\pi}\,\Gamma(\delta - \frac{1}{2})}{2\,{}^{\mu}/_{\mu_0}\Gamma\delta}\right)^2} \tag{11}$$

If the number of observed failures is less than or equal to c, then from equation (7) one can make the confidence statement that $F(t/\mu; \beta, \delta) \le F(t/\mu_0; \beta, \delta)$ with probability P^*. Note that the shape parameter δ is assumed to be known.

The minimum values of n satisfying equation (8) are obtained and given in Table-1 for varying values of P^* and t/μ_0.

5. Operating Characteristics (OC)

The OC function of the sampling plan $(n, c, t/\mu_0)$ is the probability of accepting a lot and is given by

$$L(p) = \sum_{i=0}^{c} \binom{n}{i} p^i (1-p)^{n-i} \tag{12}$$

Where, $p = F(t; \beta, \delta)$ is treated as a function of lot quality parameter β. The OC values for different combinations of the values of confidence level, mean ratio and experiment time ratio have been computed and are listed in Tables 3 and 4.

Further, for a given value of the producer's risk α, one may be interested in knowing what value of mean ratio μ/μ_0 will ensure the producer's risk less than or equal to α. The value of μ/μ_0 can be taken as the smallest number of μ/μ_0 (> 1) so that p satisfies the following inequality

$$\sum_{i=0}^{c} \binom{n}{i} p^i (1-p)^{n-i} \ge 1 - \alpha \tag{13}$$

Thus, for a given sampling plan $(n, c, t/\mu_0)$ at a specified confidence level P*, we have also computed the smallest values of μ/μ_0 satisfying the inequality (13).

The following algorithm is utilized to construct the tables of the proposed sampling plans:

Step-1: Set a given probability of accepting a bad lot (1−P*).
Step-2: Find the smallest sample size *n* for each predetermined value of acceptance number c satisfying the inequality (8).
Step-3: For a given producer's risk α , find the smallest value of μ/μ_0 which satisfies the inequality (13).

6. Illustrative Example

In this section, we discuss a numerical example for highlighting the practical aspects of the theoretical developments. Assuming that the lifetimes of the testing equipments follow compound Rayleigh distribution with known shape parameter δ, the numerical results are presented in Tables 1-5. In Table-1, we provide the minimum sample size required to state that the mean life exceeds at a given value μ_0 with consumer's confidence level P* and corresponding acceptance number c when $\delta = 1$. Table-2 presents the OC values for different combinations of the values of probability P*, mean ratio μ/μ_0 and experiment time ratio t/μ_0 for $\delta = 1$ and c=0. The OC values for the proposed sampling plan corresponding to Rayleigh and compound Rayleigh life time distributions have also been computed for varying values of P*, t/μ_0, μ/μ_0 and δ and are listed in Tables 3-4. Finally, Table 5 summarises the minimum ratios of the true mean life μ to the specified mean life μ_0 for the acceptance of the lot with producer's risk of 0.05. We have also plotted the required sample size against the experiment time ratio t/μ_0 for fixed c=0 and varying P* in Figure 1 and for fixed P*=0.90 and varying acceptance number c in Figure 2. In Figures 3-4, we draw OC curves against mean ratio μ/μ_0 for (fixed a=0.8 and varying P*=0.75, 0.90, 0.95, 0.99) and for (fixed P*=0.90 and varying a=0.4, 0.8, 1.5, 2.5) respectively. Figure 5 depicts the OC curves for varying mean ratio and with fixed P*=0.95 and a=0.6 corresponding to Rayleigh and compound Rayleigh life time distributions. Figures 6-7 show the behaviour of the minimum required mean ratios against experiment time ratios for (fixed c=1 and varying P*=0.75, 0.90, 0.95, 0.99) and for (fixed P*=0.90, α=0.05 and varying c=2, 4, 6) respectively. For all numerical computations, the programs have been developed in R-software.

7. Statistical Analysis

Suppose the experimenter is interested in establishing a sampling plan to ensure that the mean lifetime is at least say 30 days with confidence level of 90%. The experimenter wishes to stop the experiment at t= 24 days. Then for an acceptance number $c = 0$, the required sample size (n) corresponding to the values of P*= 0.90, $t/\mu_0 = 0.8$ is 5 [Table 1]. Thus, we can say that if 5 units have to be put on test and no more than 0 failures out of 5 is observed during 24 days, then the experimenter can assert that the mean lifetime of the product is at least 30 days with a confidence level of 0.90. For the sampling plan ($n = 5$, $c = 0$, $t/\mu_0 = 0.8$) and confidence level P* = 0.90 under compound Rayleigh distribution, the OC values can be found from Table-2 and are as follows:

μ/μ_0	1	2	4	6	8	10
OC	0.058288	0.368535	0.753993	0.879158	0.929486	0.954084

From the above tabulated values of the OC function, it is observed that if the true mean lifetime is double the specified lifetime (μ/μ_0 = 2), then the producer's risk will be (1-0.3685=0.6315), while it is about 0.046 when the true mean lifetime is ten times of the specified mean life. Thus, the producer's risk tends to decrease for the higher values of the mean ratios. More so, we can also get the smallest values of μ/μ_0 for various choices of c and t/μ_0 from Table 5 in order to claim that the producer's risk is less than or equal to 0.05. In particular, the smallest value of μ/μ_0 is 9.57 for c = 0, t/μ_0 = 0.8 and P* = 0.90; this means that the item should have a mean lifetime of at least 9.57 times of the specified mean life of 30 days in order that the lot will be accepted with the probability 0.95. Thus, the proposed sampling plan can be utilized to maintain the quality of the product in terms of its average life according to the consumer's standard at fixed producer's risk.

8. Concluding Remarks

Acceptance sampling plans have been specifically used in industry to determine whether a certain lot of manufactured or purchased items satisfy a pre specified quality. In this paper, reliability sampling plan has been developed to deal with the lots sentencing problem; aiming to determine an optimal sample size to provide desired levels of protection for customers as well as manufacturers when test unit follows compound Rayleigh distribution. The following are the general interpretations of the numerical findings given in Tables 1-5.

Interpretation of required sample size:

- The minimum sample size for zero acceptance sampling plan need to be very low as compare to one and more acceptance number for any combination of confidence level and experiment time ratio.
- For fixed confidence level and acceptance number, when we increase experiment time ratio the minimum sample size required to reach the decision tend to low.
- For fixed acceptance number and varying experiment time ratio, the minimum sample size required to reach a decision tend to uniformly high as we increase the confidence level.

Interpretation of the behaviour of OC curve:

- For fix experiment time ratio and varying mean ratio, the probability of acceptance is uniformly decreasing with an increase in the confidence level. The same trend is observed in respect of experiment time ratio for fix confidence level.
- For fixed confidence level and experiment time ratio, the probability of acceptance tends to increase as we increase the mean ratio.
- When we compare the OC curve corresponding to Rayleigh and Compound Rayleigh lifetime distributions, it is observed that for any fixed value of consumer's confidence level and experiment time ratio, the OC curve has uniformly low values in case of compound Rayleigh distribution as compare to Rayleigh distribution. That means for Rayleigh distribution, the probabilities of acceptance of lot are higher as compared to the compound Rayleigh distribution. This may happen due to the incorporation of the past parametric fluctuations with the experimental data.

Interpretation for the minimum required mean ratio at fixed producer's risk:

- we observe that the minimum mean ratios required for zero acceptance sampling plan in order that the lot will be accepted with the probability (1-α) are very high as compared to one and more acceptance number for any combination of confidence level and experiment time ratio.
- For fixed acceptance number, the required minimum means ratio increases uniformly as we increase the confidence level.

Thus, after analysing the trends of the results given in Tables 1-5 and Figures 1-7, one can make the trade off between the required minimum sample size, confidence level, acceptance number and experimental time ratio to achieve the best sampling plan.

References

1. Aslam, M. and Shahbaz, M. Q. (2007). Economic reliability tests plans using the generalized exponential distribution, Journal of Statistics, 14, p. 52-59.
2. Baklizi, A. and El Masri, A. E. K. (2004). Acceptance sampling based on truncated life tests in the Birnbaum–Saunders model, Risk Anal. 24, p. 1453–1457.
3. Bhattacharya, S. K. and Tyagi, R. K. (1990). Bayesian survival analysis based on the Rayleigh model, Trabajos de Estadistica, vol. 5, no.1, p. 81-92.
4. Gupta, S.S. and Groll, P.A. (1961). Gamma distribution in acceptance sampling based on life tests, J. Amer. Statist. Assoc, 56, p. 942 – 970.
5. Kantam, R. R. L., Rosaiah, K., Rao, G. S. (2001). Acceptance sampling based on life tests: log-logistic models, J. Appl. Statist. 28, p. 121–128.
6. Kantam, R.R.L. and Rosaiah, K., (1998). Half logistic distribution in acceptance sampling based on life tests, IAPQR Transactions. 23 (2), p. 117 – 125.
7. Khan, M.A. and Islam, H.M. (2010). On the robustness of reliability characteristic of alpha distributed lifetimes, Econ. Qual. Cont. Journal, 25(2), p. 173-181.
8. Mostert, P. J., Bekker, A. and Roux, J. J. J. (1998). Bayesian analysis of survival data using the Rayleigh model and linex loss, South African Statistical Journal, vol. 32, no. 1, p. 19-42.
9. Polovko, A. M. (1968). Fundamentals of Reliability Theory, Academic Press: New York.
10. Raqab, M. Z. and Madi, M. T. (2002). Bayesian prediction of the total time on test using doubly censored Rayleigh data, Journal of Statistical Computation and Simulation, 72, p. 781-789.
11. Tsai, T.-R. and Wu, S.-J. (2006). Acceptance sampling based on truncated life tests for generalized Rayleigh distribution, Journal of Applied Statistics, 33, p. 595-600.

Table 1. Minimum sample size n to be tested for a time t in order to assert with probability P* acceptance number c (when shape parameter $\delta = 1$)

P*	c	a (t/μ_0) 0.4	0.6	0.8	1	1.5	2	2.5	3
0.75	0	12	5	3	2	1	1	1	1
	1	22	11	6	4	3	2	2	2
	2	33	15	9	7	4	3	3	3
	3	43	20	12	9	5	4	4	4
	4	52	25	15	11	7	5	5	5
	5	62	29	18	13	8	6	6	6
	6	72	34	21	15	9	8	7	7
	7	81	38	24	17	10	9	8	8
	8	91	43	26	19	12	10	9	9
0.90	0	19	9	5	3	2	1	1	1
	1	32	15	9	6	3	2	2	2
	2	44	20	12	8	5	4	3	3
	3	55	26	15	11	6	5	4	4
	4	66	31	19	13	8	6	5	5
	5	77	36	22	15	9	7	6	6
	6	87	41	25	17	10	8	7	7
	7	98	46	28	19	12	9	8	8
	8	108	51	31	22	13	10	9	9
0.95	0	24	11	6	4	2	1	1	1
	1	39	18	10	7	4	3	2	2
	2	52	24	14	10	5	4	3	3
	3	64	29	18	12	7	5	4	4
	4	75	35	21	14	8	6	5	5
	5	87	40	24	17	10	7	6	6
	6	98	46	27	19	11	8	8	7
	7	109	51	30	21	12	10	9	8
	8	119	56	33	23	14	11	10	9
0.99	0	37	17	10	6	3	2	1	1
	1	54	24	14	9	5	3	3	2
	2	68	31	18	12	6	5	4	3
	3	82	38	22	15	8	6	5	4
	4	95	44	26	17	9	7	6	5
	5	107	49	29	20	11	8	7	6
	6	119	55	33	22	12	9	8	7
	7	131	61	36	25	14	10	9	8
	8	143	66	39	27	15	12	10	9

Table 2. Value of operating characteristic function of the sampling plans for compound Rayleigh Distribution (when δ =1 & c=0)

P*	a	Mean ratio					
		1	2	4	6	8	10
75	0.4	0.189437	0.624615	0.885261	0.946928	0.96972	0.980492
	0.6	0.148529	0.547918	0.850364	0.929486	0.959492	0.973819
	0.8	0.150332	0.514027	0.828409	0.917723	0.95242	0.96915
	1	0.083175	0.382526	0.750634	0.875829	0.927134	0.95242
	1.5	0.152633	0.418776	0.742403	0.866392	0.920179	0.947404
	2	0.092	0.2884	0.618486	0.784833	0.866392	0.91017
	2.5	0.060897	0.20596	0.509209	0.7001	0.80583	0.866392
	3	0.043091	0.152633	0.418776	0.618486	0.742402	0.818286
90	0.4	0.097376	0.517437	0.843141	0.926496	0.957866	0.972796
	0.6	0.078659	0.448354	0.805638	0.907104	0.946358	0.965245
	0.8	0.058288	0.368535	0.753993	0.879158	0.929486	0.954084
	1	0.083175	0.382526	0.750634	0.875829	0.927134	0.95242
	1.5	0.023297	0.175373	0.551161	0.750634	0.84673	0.897573
	2	0.092	0.2884	0.618486	0.784833	0.866392	0.91017
	2.5	0.060897	0.20596	0.509209	0.7001	0.80583	0.866392
	3	0.043091	0.152633	0.418776	0.618486	0.742402	0.818286
95	0.4	0.035886	0.390144	0.783687	0.896672	0.940357	0.961365
	0.6	0.041657	0.366882	0.763264	0.885261	0.933403	0.956746
	0.8	0.0226	0.264224	0.686262	0.842215	0.907104	0.939252
	1	0.023988	0.236587	0.650343	0.819651	0.892717	0.929486
	1.5	0.023297	0.175373	0.551161	0.750634	0.84673	0.897573
	2	0.008464	0.083175	0.382525	0.615964	0.750634	0.828409
	2.5	0.003708	0.042419	0.259294	0.490139	0.649361	0.750634
	3	0.043091	0.152633	0.418776	0.618486	0.742402	0.818286
99	0.4	0.009482	0.267741	0.710886	0.858395	0.917508	0.946333
	0.6	0.006187	0.201021	0.649052	0.822838	0.895593	0.931697
	0.8	0.008763	0.189437	0.624615	0.806823	0.885261	0.92465
	1	0.006918	0.146326	0.563452	0.767076	0.859578	0.907104
	1.5	0.003556	0.073442	0.409184	0.650343	0.779144	0.850364
	2	0.008464	0.083175	0.382525	0.615964	0.750634	0.828409
	2.5	0.003708	0.042419	0.259294	0.490139	0.649361	0.750634
	3	0.001857	0.023297	0.175373	0.382525	0.551161	0.669593

Table 3. Value of operating characteristic function of the sampling plans for Rayleigh and compound Rayleigh Distribution (when c=0)

P*	a	Mean ratio (Rayleigh)					
		1	2	4	6	8	10
0.75	0.6	0.243238	0.702276	0.915434	0.961491	0.978153	0.985962
0.90	0.6	0.078497	0.529315	0.85296	0.931755	0.961019	0.974874
0.95	0.6	0.044593	0.459533	0.82334	0.917233	0.952565	0.969377
0.99	0.6	0.008175	0.300695	0.740511	0.875012	0.927647	0.953071
P*	a	Mean ratio (compound Rayleigh, $\delta = 1$)					
		1	2	4	6	8	10
0.75	0.6	0.148529	0.547918	0.850364	0.929486	0.959492	0.973819
0.90	0.6	0.078659	0.448354	0.805638	0.907104	0.946358	0.965245
0.95	0.6	0.041657	0.366882	0.763264	0.885261	0.933403	0.956746
0.99	0.6	0.006187	0.201021	0.649052	0.822838	0.895593	0.931697
P*	a	Mean ratio (compound Rayleigh, $\delta = 1.5$)					
		1	2	4	6	8	10
0.75	0.6	0.214934	0.649931	0.894712	0.951466	0.972343	0.982193
0.90	0.6	0.085445	0.501866	0.836938	0.923483	0.956118	0.971661
0.95	0.6	0.046197	0.422411	0.80051	0.905287	0.945452	0.964703
0.99	0.6	0.009929	0.274538	0.716226	0.861349	0.919304	0.947524
P*	a	Mean ratio (compound Rayleigh, $\delta = 2$)					
		1	2	4	6	8	10
0.75	0.6	0.245662	0.685085	0.908023	0.957867	0.976045	0.984593
0.90	0.6	0.090129	0.522901	0.847551	0.928862	0.959287	0.973733
0.95	0.6	0.049383	0.444656	0.813218	0.911883	0.94937	0.967274
0.99	0.6	0.009927	0.288605	0.728313	0.868107	0.923424	0.950261

Table 4. Value of operating characteristic function of the sampling plans for Rayleigh and compound Rayleigh Distribution with P*=0.95, a=0.6 and different shape parameter

		Mean ratio					
		1	2	4	6	8	10
RAY		0.044593	0.459533	0.82334	0.917233	0.952565	0.969377
Com. RAY	$\delta = 1$	0.041657	0.366882	0.763264	0.885261	0.933403	0.956746
Com. RAY	$\delta = 1.5$	0.046197	0.422411	0.80051	0.905287	0.945452	0.964703
Com. RAY	$\delta = 2$	0.049383	0.444656	0.813218	0.911883	0.94937	0.967274

Table 5. Minimum ratio of true value μ to specified μ0 for the acceptability of a lot with producer's risk 0.05.

P*	c	a							
		0.4	0.6	0.8	1	1.5	2	2.5	3
0.75	0	6.188	7.177	7.797	9.746	10.271	13.694	17.118	20.541
	1	3.038	3.276	3.821	3.971	5.956	5.854	7.318	8.781
	2	2.363	2.666	2.955	3.252	4.097	5.462	5.142	6.171
	3	2.067	2.244	2.571	2.575	3.264	4.352	4.147	4.976
	4	1.898	2.116	2.169	2.463	2.78	3.706	4.632	4.269
	5	1.787	1.941	2.06	2.165	2.884	3.275	4.094	3.793
	6	1.709	1.818	1.981	2.142	2.603	2.963	3.704	4.444
0.9	0	7.327	8.297	9.57	9.746	14.619	13.694	17.118	20.541
	1	3.699	3.97	4.368	4.777	5.956	7.941	9.926	8.781
	2	2.829	3.049	3.269	3.694	4.877	5.462	6.828	8.193
	3	2.391	2.645	2.79	3.214	3.862	4.352	5.44	6.528
	4	2.192	2.32	2.517	2.711	3.274	3.706	4.632	5.559
	5	2.026	2.19	2.34	2.575	3.247	3.846	4.094	4.912
	6	1.909	2.031	2.214	2.476	2.926	3.471	3.704	4.444
0.95	0	8.762	9.282	11.062	11.962	14.619	19.492	24.365	20.541
	1	3.988	4.557	4.853	5.46	7.165	7.941	9.926	11.911
	2	2.995	3.222	3.555	4.087	4.877	5.462	6.828	8.193
	3	2.567	2.766	2.992	3.214	3.862	5.149	5.44	6.528
	4	2.326	2.508	2.673	2.937	3.694	4.365	4.632	5.559
	5	2.17	2.341	2.467	2.756	3.247	3.846	4.807	4.912
	6	2.031	2.16	2.321	2.626	3.213	3.471	4.339	4.444
0.99	0	10.371	11.752	12.376	13.827	17.943	19.492	24.365	29.238
	1	4.751	5.077	5.698	6.066	8.19	9.553	11.941	11.911
	2	3.515	3.839	4.065	4.443	5.541	6.503	8.128	9.754
	3	2.935	3.203	3.527	3.739	4.82	5.826	6.436	7.723
	4	2.61	2.846	3.094	3.342	4.067	4.925	5.456	6.548
	5	2.433	2.616	2.814	3.084	3.863	4.33	5.412	5.768
	6	2.255	2.455	2.616	2.902	3.473	3.902	4.877	5.206

Figure 1: Sample size vs.experiment time ratio(t/μ0) with acceptance number 'c'=0

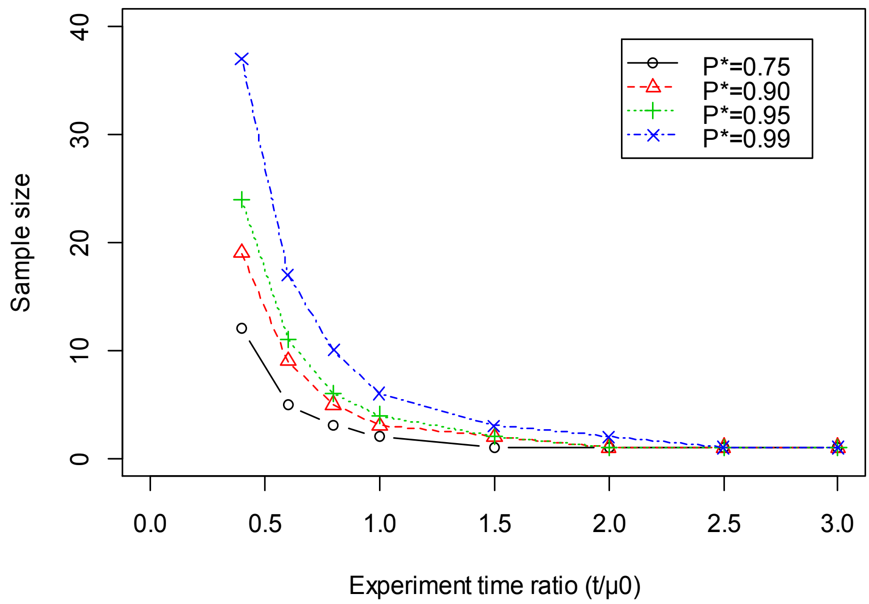

Figure 2: Sample size vs.experiment time ratio(t/μ0) with confidence level 'P*'=0.90

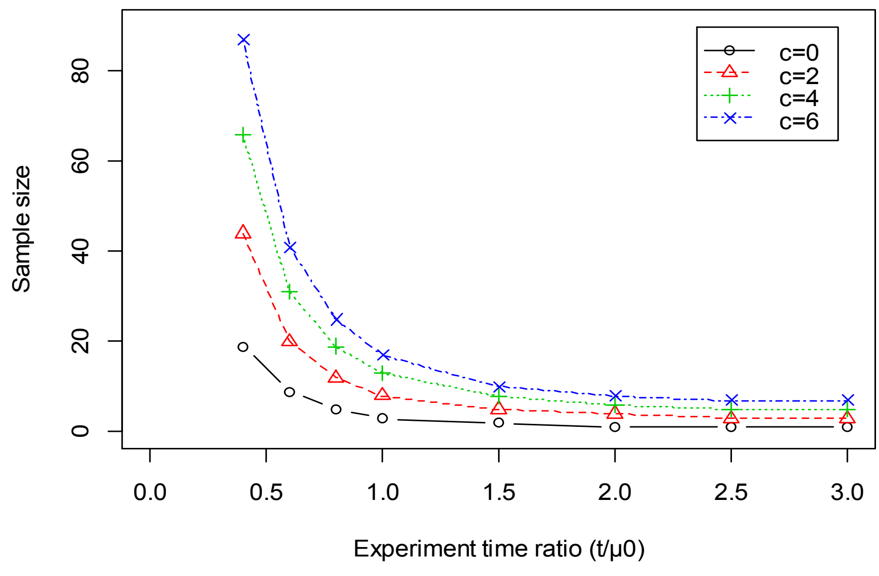

Figure 3: OC values vs. mean ratio 'μ/μ0' with Experiment time ratio (a)=0.8

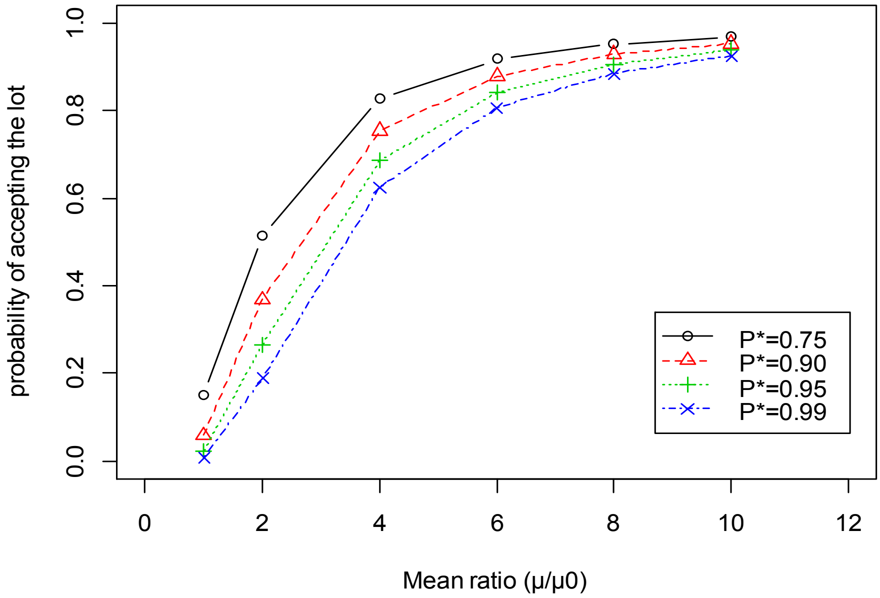

Figure 4: OC values vs. mean ratio (μ/μ0) with confidence level (P*)=0.90

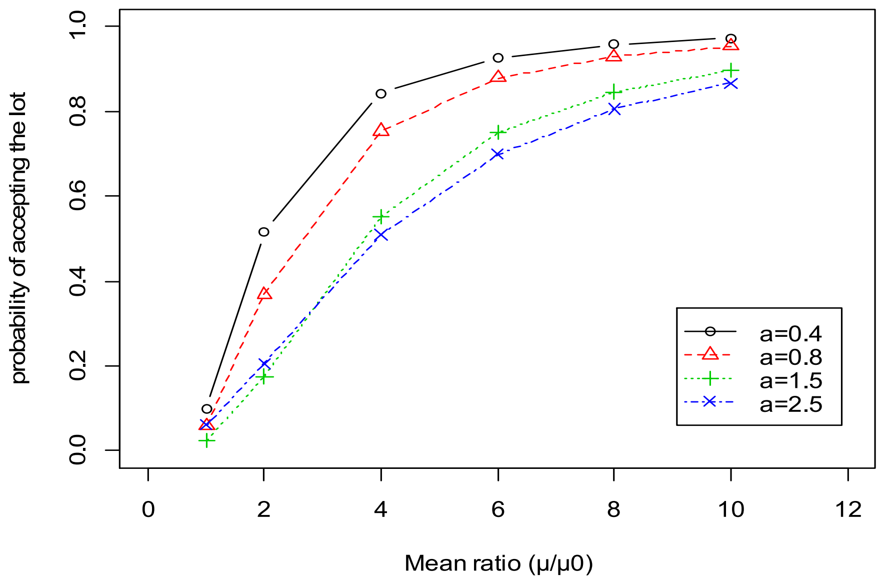

Figure 5: OC values vs. mean ratio (μ/μ0)with confidence level (P*)=0.95 & Experiment time ratio (a)=0.6

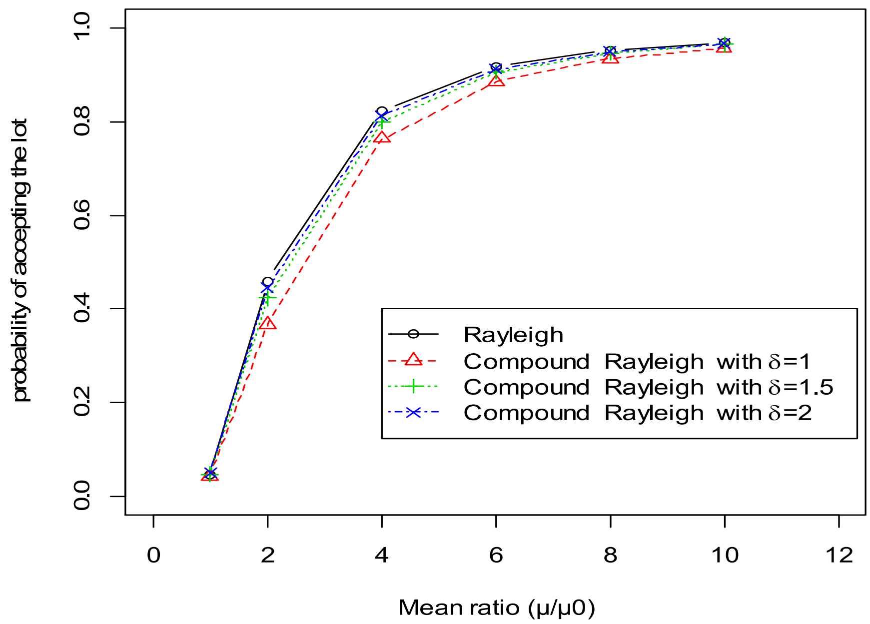

Figure 6: minimum required mean ratio(μ/μ0) vs.experiment time ratio(t/μ0) with Acceptance level (c)=1

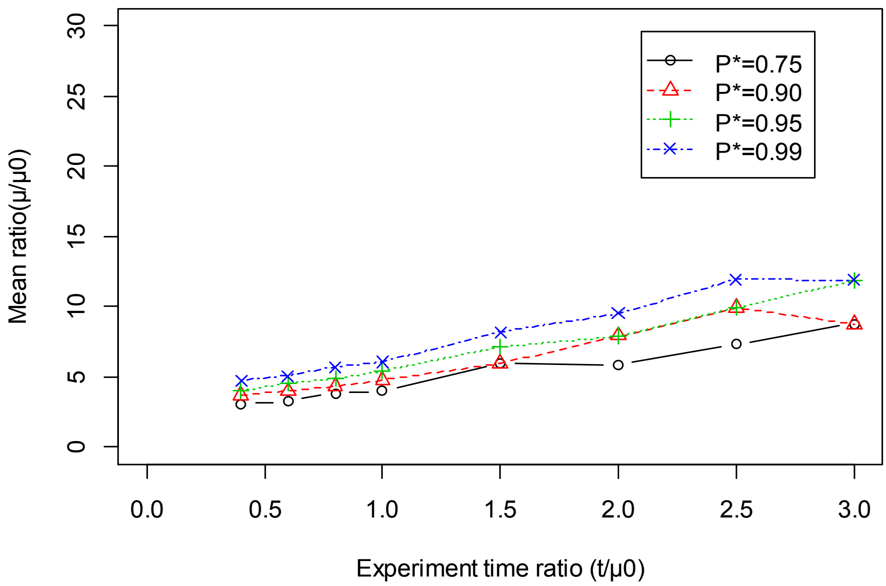

Figure 7: minimum required mean ratio (μ/μ0)vs.experiment time ratio(t/μ0) with confidence level(P*)=0.95 & producer's risk=0.05