

# Model Document: CBE Paper

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Top, bottom, right and left margins should be between 1 and 1.5 inches.

Title is centered (separate title page may be used).

Summary of paper in past tense.

Section titles are centered.

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The Determination of the Most Probable Genetic Cross  
Which Produced an Unknown Cob of Corn (Zea mays)

Abstract

The analysis of an unknown cob of corn was conducted to determine the most probable genetic cross that produced it. Phenotypes for aleurone color and starch content were recognized for each of the total 460 kernels. Alleles for aleurone color were found to be dominant for purple (R) and recessive for yellow (r). Alleles for endosperm starch content were found to be dominant for starchy endosperms (Su) and recessive for sweet endosperms (su). The phenotype ratio of the unknown cob of corn was 1.04:1.00:1.03:1.16 for R\_Su\_, R\_susu, rrSu\_, and rrsusu kernels respectively. The most probable genetic cross was RrSusu rrsusu or Rrsusu rrSusu.

Introduction

The foundation of modern genetics can be attributed, in large part, to the work of Gregor Mendel. He conducted hybridization experiments on the garden pea,

determining dominant and recessive alleles in peas. Using mathematics and probabilities, he also found that the genotypic ratios of the offspring from hybrid crosses could be predicted. This was based on the possible alleles that could be donated in the gametes of each parent organism (Gardner 1960).

Mendel's work can also be applied to the genetics of corn. However, there is greater complexity in hybrid crosses than Mendel's experiments reveal. In 1911, G. N. Collins and J. H. Kempton found the first clearly recognized linkage in corn, discovering that the gene for the waxy endosperm is linked to the gene for aleurone color (Gardner 1960). This discovery led to the concept of crossing-over, in which segments of homologous chromosomes break and exchange genes creating genetic recombinations. Therefore, the genotypic ratios for the offspring of hybrid crosses do not always coincide with Mendelian ratios.

The purpose of my experiment was to analyze the phenotype expressed in the kernels of an unknown cob of corn and determine the most probable genetic cross that produced it.

#### Methods and Materials

A cob of corn of unknown parentage was analyzed.

Introduction provides brief background of pertinent literature.

Name-year method used for in-text citations.

Introduction ends with objective of study.

Passive voice emphasizes the process rather than the researcher.

Analysis consisted of counting individual kernels and categorizing them according to phenotypes of aleurone color and starch content. A total of 460 kernels were counted and placed in categories of either purple aleurone / starchy endosperm, purple aleurone / sweet endosperm, yellow aleurone / starchy endosperm, or yellow aleurone / sweet endosperm.

Dominant and recessive alleles for aleurone color were determined by the analysis of a separate cob of corn. Each kernel was counted according to color. Phenotypic ratios were calculated from which the monohybrid cross was deduced. Dominant and recessive alleles for starch content were determined with the analysis of another cob of corn in which the kernels were counted for each phenotype. Phenotypic ratios were calculated, and the monohybrid cross was deduced.

A phenotypic ratio for the unknown was then calculated, and the hypothesis for the most probable genetic cross of the parent corn was deduced.

#### Results

The monohybrid corn cob analyzed for dominant and recessive alleles for aleurone color had 106 yellow kernels and 282 purple kernels out of a total 388 kernels. The phenotypic ratio was 1:2.7. The calculated

Chi-square value was 1.113 for the hypothesis of a heterozygous cross.

The monohybrid corn analyzed to determine dominant and recessive alleles for starch content had 110 sweet kernels and 317 starchy kernels out of a total of 427 kernels. The phenotypic ratio was 1:2.9. The calculated Chi-square value was 0.132 for the hypothesis of a heterozygous cross.

The unknown cob of corn analyzed had kernels which exhibited phenotypes of purple or yellow aleurones, and starchy or sweet endosperms. Of the total 460 kernels, 24.6% were purple starchy, 23.7% purple sweet, 24.3% yellow starchy, and 27.4% yellow sweet (Table 1). The phenotypic ratio was 1.04:1.00:1.03:1.16.

Reference to table at end of paper.

#### Discussion and Conclusions

The development of the endosperm starts with the initial triploid nucleus which begins rapid divisions within 2 to 4 hours after fertilization (Knowles 1990). Sixteen to 30 days after pollination, genes are activated that specify the increase of enzymes involved in the synthesis of stored products, such as starch. From 31 to 50 days after pollination, there is continued synthesis of the major storage products. The endo-

Number spelled out at beginning of sentence.

sperm changes as structures specialized for the storage of starch enlarge (Walden 1978).

Discussion elaborates on results.

The unknown cob of corn had kernels which were smooth and dented. These kernels had starchy endosperms that had gone through the process of converting plant sugar to starch and storing it. Other kernels were smaller and wrinkled. These kernels were identified as sweet endosperms. Sweet endosperms do not convert as much plant sugar to starch and therefore have a lower starch content than starchy endosperms.

The outermost portion of the endosperm is the aleurone zone. The aleurone cells are thick-walled and cubical in shape; they compose a layer which is usually one cell layer thick (Hayward 1938). The unknown cob of corn analyzed exhibited aleurones of two colors, purple and yellow.

Other studies included for comparison.

A complimentary experiment on a separate cob of corn was used to determine the dominant and recessive alleles for the aleurone color. The phenotypic ratio of yellow to purple kernels was 1:2.7. A hypothesis of a heterozygous monohybrid cross ( $Rr \times Rr$ ) predicts a 1:3 ratio of yellow to purple aleurones. This expected ratio is very close to the experimental ratio, so it is probable that the purple phenotype is  $R_$ , and the yellow phenotype is  $rr$ . Purple would therefore be

the dominant allele, and yellow would be the recessive allele.

A similar experiment with another cob of corn was used to determine the dominant-recessive relationship between starchy and sweet endosperm alleles. The phenotypic ratio of sweet to starchy endosperms was 1:2.9. A hypothesis of a heterozygous monohybrid cross (Susu x Susu) predicts a ratio of 1:3 for sweet endosperms to starchy endosperms. The experimental ratio is very close to the expected ratio. Therefore, it is probable that the starchy phenotype is Su\_, and the sweet phenotype is susu. The starchy endosperm would be the dominant allele, and the sweet endosperm, the recessive.

Using the information obtained for the dominant and recessive alleles, the unknown cob of corn is probably the product of a dihybrid cross. The experimental phenotypic ratio of 1.04:1.00:1.03:1.16 is very close to the known ratio of 1:1:1:1. This known ratio can be obtained by two possible dihybrid crosses. There is an equal probability that either of the two crosses could have resulted in the production of the unknown cob of corn.

The unknown cob of corn could have been produced by a dihybrid cross, in which one of the parents was heterozygous for both aleurone color and starch content

(RrSusu) and the other parent was homozygous recessive for both traits (rrsusu). Based on the possible gametes that each parent could produce, this hypothesis predicts offspring which are 25% purple starchy (RrSusu), 25% purple sweet (Rrsusu), 25% yellow starchy (rrSusu), and 25% yellow sweet (rrsusu) (see Figure 1). These expected results are close to the actual experimental data, and the hypothesis was accepted.

The other possible dihybrid cross is one in which a parent that was heterozygous for aleurone color and homozygous recessive for starch content (Rrsusu) is crossed with a parent that was homozygous recessive for aleurone color and heterozygous for starch content (rrSusu). This dihybrid cross also predicts offspring which are 25% purple starchy (RrSusu), 25% purple sweet (Rrsusu), 25% yellow starchy (rrSusu), and 25% yellow sweet (rrsusu) (see Figure 2). This hypothesis was also accepted.

For the two hypotheses of the genetic crosses resulting in the production of the unknown cob of corn, the Chi-square value is the same, 1.478. This value is less than the critical value of 7.82 at a significance level of 0.05. Therefore, both hypotheses are acceptable, but the more probable of the two hypotheses cannot be determined from these data.

Conclusion interprets results concisely.

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over list.

In name-year system,  
entries are  
alphabetized by  
author.

#### References

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Table has title, and data is presented in columns.

Table 1 Numbers of kernels in each row of the unknown cob of corn exhibiting specific phenotypes

Row	Purple Aleurone and Starchy Endosperm	Purple Aleurone and Starchy Endosperm	Yellow Aleurone and Starchy Endosperm	Yellow Aleurone and Starchy Endosperm
1	12	9	6	8
2	9	4	13	11
3	8	7	13	10
4	10	10	6	12
5	10	8	12	10
6	8	9	10	13
7	9	10	8	12
8	6	8	12	13
9	10	13	8	9
10	12	15	5	9
11	9	8	11	8
12	10	8	8	11
Total	113	109	112	126

Figures are labeled with captions.

gametes	Rsu	rSu	Rsu	rsu
rsu	RrSusu	rrSusu	Rrsusu	rrsusu

Figure 1 Possible gametes in a RrSusu x rrsusu cross and the offspring produced

gametes	Rsu	rsu
rSu	RrSusu	rrSusu
rsu	Rrsusu	rrsusu

Figure 2 Possible gametes in a Rrsusu x rrSusu cross and the offspring produced