Does Feminizing Cannabis seed produce the same Variety of Cannabis?

By John Birrenbach, Dec 2023

AI assisted in computing genetic outcomes

The quick answer is No, the vast majority of seeds from self-fertilization won't be identical to the parent plant, although they'll share many characteristics. They'll be similar to plants from regular fertilization except all are guaranteed female.

Many will be similar in various aspects but there will be differences. The more times a plant is feminized the differences will become greater. In the first round of self-fertilization will create a possibility of up to **16 possible combinations.**

If you get deeper into the cannabinoid profile of the plant variety using the self-fertilization process you could produce **1,048,576 possible cannabinoid profile combinations,** in the seeds produced.

Given that varieties are based on the cannabinoid profile of the plant it will be very hard to produce exact results and it will become increasingly difficult in future generations of a variety.

The principle of fertilization remains the same and the same randomization occurs with the genetic structure of the seed produced whether the plant is a female or male. The main difference is female/female pollination creates female seeds vs the 50/50 split of male n female with regular fertilization. Given the desire to produce female plants this is an advantage to some.

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The full answer:

In order to answer this question we need to get into the genetics of Cannabis.

Cannabis is a diploid (pairs of chromosomes composed of genes), independent assortment (how different genes independently separate from one another when reproductive cells develop), 10 chromosome pairs, species of plant.[1]

Scientists estimate there are around 80-140 different cannabinoids in cannabis, but the exact number might be different..[2]

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[1] Recent advances in *Cannabis sativa* genomics research **https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7986631/**

It has so far been determined that 2 of cannabis's 10 chromosomes, #6 and #7, are responsible for the production of THC and CBD cannabinoids the main cannabinoids sought after in Cannabis cultivation.[3]

The number of genes needed to produce THC and CBD are not known but it can be estimated.

So how many genes are used to produce the cannabinoids in a Cannabis plant?

Estimating the exact number of genes involved in producing 80-140 cannabinoids in cannabis with only the information about the number of chromosomes and cannabinoids is challenging. However, we can explore some possible ranges and factors to consider:

Range of possibilities:

- **Minimum estimate:** Considering a scenario where each cannabinoid is produced by a unique gene located on a different chromosome, the minimum number of genes would be 80-140 (one for each cannabinoid). However, this is highly unlikely because related cannabinoids likely share some genetic similarity.
- **Maximum estimate:** In a scenario where a small number of genes contribute to most cannabinoids through variations and combinations, the number of genes could be significantly lower. **A rough estimate could be around 10-20 genes**, assuming each gene contributes to multiple cannabinoids with slight variations.

Factors influencing the actual number:

- **Gene complexity and redundancy:** As mentioned earlier, some cannabinoids might share similar structures, suggesting variations within the same gene or closely related genes. On the other hand, highly diverse cannabinoids likely involve distinct sets of genes. This can vary the total number needed.
- **Pleiotropy:** Some genes might influence the production of multiple cannabinoids, while others might be specific to one. This complicates the counting of individual genes involved.
- **Regulatory elements and epigenetic modifications:** Beyond the coding sequences, gene expression and cannabinoid production are influenced by regulatory elements and epigenetic modifications, adding another layer of complexity.

Current understanding:

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[2] Cannabis (Marijuana) and Cannabinoids: What You Need To Know **https://www.nccih.nih.gov/health/cannabis-marijuana-and-cannabinoids-what-you-need-to-know**

[3] World's First Cannabis Chromosome Map Reveals the Plant's Evolutionary History **https://www.mountsinai.org/about/newsroom/2018/worlds-first-cannabis-chromosome-map-reveals-the-plants-evolutionary-history**

Research on cannabis genetics is ongoing, and the exact number of genes involved in cannabinoid production is still being investigated. Some studies suggest the involvement of dozens of genes, while others hint at a potentially smaller number with complex interactions.

Conclusion:

While definitive answers await further research, the number of genes responsible for the 80-100 cannabinoids in cannabis likely falls somewhere between **10 and 80**. However, this is a broad range, and the actual number depends on factors like gene complexity, redundancy, and regulatory mechanisms.

Section 2:

In the production of Feminized Cannabis seed a plant of the same type is forced to produce pollen, which is then used to pollenate the same plant creating all female seed in the process.

So is this going to produce seed that is true to its parentage? Let's examine the genetics of this.

If the same chromosomes are used in breeding how many different chromosomes combinations are produced?

When considering a cannabis plant with two diploid chromosomes that independently assort and contribute to the production of both THC and CBD, the number of possible chromosome combinations becomes more complex but can still be estimated. Here's a breakdown:

Factors influencing combinations:

1. **Independent assortment:** As mentioned, independent assortment allows for greater variation as chromosomes don't influence each other's movement during meiosis.
2. **Diploid chromosomes:** Each chromosome exists in pairs, with one copy inherited from each parent. This doubles the potential allelic combinations.
3. **Multiple genes:** THC and CBD production likely involve multiple genes spread across chromosomes, further increasing the possible combinations.
4. **Allelic variations:** Each gene can have different alleles (versions) influencing THC and CBD production levels.

Estimating combinations:

1. **Single gene per chromosome:** Assuming one gene per chromosome for simplicity, each chromosome can have two alleles (let's call them A and a). This leads to 2 x 2 = 4 possible combinations per chromosome.
2. **Two chromosomes:** With two independent chromosomes, the total number of combinations becomes 4 x 4 = **16 possible combinations**.

Further considerations:

- **Multiple genes:** If multiple genes are involved (likely for complex traits like THC and CBD production), the number of combinations multiplies for each additional gene. For example, with two genes per chromosome, the combinations would be 4 x 4 x 4 x 4 = 256.
- **Dominant/recessive alleles:** The inheritance patterns of each gene's alleles (dominant, recessive, or codominant) influence the observed phenotypes (THC and CBD levels) from different combinations.
- **Gene interactions:** Genes might interact with each other, adding another layer of complexity to predicting phenotypes from specific combinations.

Therefore, while the basic estimate for two diploid chromosomes with independent assortment is **16 combinations**, the actual number influencing THC and CBD production in cannabis breeding can be much higher and depends on various factors.

Visualization:

Imagine each chromosome as a straight line with two possible alleles represented by circles (e.g., A and a). Independent assortment allows these lines to combine in different ways during meiosis, creating unique combinations like:

- AA Aa aA aa (for one gene per chromosome)
- AABB AABa AaBB AaBb Aaba aABb aaBb aabb (for two genes per chromosome)

Remember, this is a simplified visualization, and the actual genetic complexity is much greater.

Part 3

Assuming 10 genes are involved and the same chromosomes are used in breeding how many different chromosomes combinations are produced?

When a cannabis plant utilizes 2 diploid, independently assorting chromosomes and 10 genes are involved in producing THC and CBD, the number of potential chromosome combinations becomes incredibly vast. Here's how to estimate it:

Individual Gene Combinations:

- Each gene possesses 2 alleles (diploid) and assorts independently.
- This translates to 4 possible combinations (2 x 2) for each individual gene.

Total Combinations:

- With 10 genes, the total number of combinations across all genes reaches a staggering **1,048,576** (4 x 4 x 4 x 4 x 4 x 4 x 4 x 4 x 4 x 4).

Visualization:

Imagine each chromosome as a line with ten "allele slots" filled with circles representing different alleles. Independent assortment of these chromosomes during meiosis creates a mind-bogglingly intricate network of potential combinations, resembling a complex branching tree with 1,048,576 terminal nodes.

Even this immense number is an underestimation for several reasons:

- **Incomplete Information:** We lack the exact number of genes involved, their locations on the chromosomes, and their inheritance patterns (dominant/recessive, codominant, etc.). These factors can further increase the variety of combinations.
- **Gene Interactions:** Genes can interact with each other in intricate ways, influencing THC and CBD production beyond the simple sum of individual gene combinations. This can lead to unexpected phenotypes and even higher diversity.
- **Environmental Factors:** Growing conditions, light, and nutrients can also impact cannabinoid production, adding another layer of complexity to predicting outcomes from specific chromosome combinations.

Breeding Implications:

Understanding the immense number of potential chromosome combinations in cannabis breeding is crucial. It highlights the following:

- **Extreme Complexity:** Predicting THC and CBD levels in offspring becomes incredibly challenging due to the vast array of possible combinations.
- **Advanced Breeding Techniques:** Techniques like marker-assisted selection and DNA fingerprinting become essential for identifying desirable genetic markers linked to specific cannabinoid profiles.
- **Controlled and Consistent Growing Conditions:** Minimizing environmental variability allows breeders to better assess the genetic influence on cannabinoid production.
- **Large-scale Breeding Programs:** Experimenting with numerous crosses and analyzing massive datasets can help breeders navigate the diverse genetic landscape and achieve desired cannabinoid profiles.

Remember, cannabis genetics and cannabinoid production are complex topics, and this explanation provides a simplified overview. With ongoing research, and the estimates provided are based on current understanding and potential scenarios. More comprehensive genetic studies will shed further light on the intricacies of cannabinoid production in cannabis.

Part 4: SUMMARY

Does a feminized cannabis seed always produce identical offspring?

No, the vast majority of seeds from self-fertilization won't be identical to the parent plant, although they'll share many characteristics. They'll be similar to plants from regular fertilization except all are guaranteed female.

As with standard male/female pollination many will be similar in various aspects but there will be differences. The more times a plant is feminized the greater the differences will become. In the first round of self-fertilization will create a possibility of up to **16 possible combinations.**

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