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Replacing TBHQ in Soybean and Canola Oil using GT-FORT™ 101 SF

- *Kemin's GT-FORT 101 SF can replace TBHQ in soybean and canola oil and can significantly extend the life of untreated oil*
- *GT-FORT 101 SF does not negatively impact the sensory attributes even at very high levels*
- *GT-FORT 101 SF provides a linear dose response up to maximum levels tested in OSI*

ABSTRACT

Oxidative stability index at 110 °C along with accelerated shelf life testing of bulk oils at 60 °C (Peroxide value) was used to compare efficacy of different treatments. Overall 5000 and 6000 ppm of GT-FORT™ 101 SF were comparable in efficacy to 1000 ppm of the TBHQ-based EN-HANCE® product in both soybean and canola oil.

INTRODUCTION

Soybeans are the fourth largest crop produced globally and, along with their derivatives, are the most traded agricultural commodity in the world[1]. Soybean oil is the second leading oil produced in the world and the most widely used oil in the U.S. based on consumption[2,3]. It accounts for more than 75% of the total U.S. consumer vegetable fat and oil consumption[3]. The total U.S. food use of soybean oil for the year 2015 was 19.6 billion lbs[3]. Soybean oil is relatively unstable due to the high amounts of polyunsaturated fatty acids present[4]. Canola is the second leading oil used in the U.S. based on consumption. Consumption for the year 2015 was 4.89 billion lbs[5]. The high amounts of linolenic acid as well as relatively higher amounts of chlorophyll places it in the same category as soybean oil in terms of oxidative stability[6]. Both soybean and canola oil are not suited for heavy duty industrial frying and are primarily used as salad oil, in margarine, and to some extent in par-frying[7]. High amounts of polyunsaturated fatty acids in soybean and canola has warranted the need for the use of synthetic antioxidants such as TBHQ to impart a longer shelf life. Clean label trends have placed emphasis on the removal of chemicals like BHA, BHT and TBHQ from foods. Until now, this has been a challenge since an alternative was not available. This study focuses on the Oil-Soluble Green Tea Extract (OSGT)- based product GT-FORT 101 SF as a potential alternative to TBHQ to enhance oxidative stability of commonly used commodity oils such as canola and soybean oil.

MATERIALS AND METHODS

Treatments and Dose Level Used:

1. **OSI:**

Treatment	Soybean Oil	Canola Oil
Untreated	-	-
EN-HANCE	1000 ppm (A103, 20% TBHQ)	715 ppm (A131, 28% TBHQ)
FORTIUM® MT70	-	1500 ppm
GT-FORT 101 SF	4000, 5000, 6000, 7000 and 10,000 ppm	1000, 1500, 5000, 7000 and 9000 ppm

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2. Accelerated Shelf Life:

Treatment	Soybean Oil	Canola Oil
Untreated	-	-
EN-HANCE	1000 ppm (A101, 20% TBHQ)	715 ppm (A131, 28% TBHQ)
GT-FORT 101 SF	5000 and 6000 ppm	5000 and 6000 ppm

Methods

Oxidative stability index test (OSI): OSI is a standard test in the fats/oils industry that measures the oxidative stability of oil samples at elevated temperatures with constant flow of air in the oil sample. Briefly, in a typical accelerated OSI test, 40 grams of fats/oils for each treatment were dosed with the proper amount of treatment, and the treated oils were vortexed for at least 10 seconds to ensure homogeneous dispersion into the fats/oils. The average of the duplicates was reported and standard deviation was calculated and reported. The temperature for soybean oil and canola oil was held at 110 ^{o}C.

Accelerated Shelf Life Testing:

For soybean oil and canola oil, the proper amount of treatment and 50.0 g oil were weighed into a glass vial, capped and agitated manually to ensure proper mixing of the treatment. The glass vials were stored in an incubator at 60 ^{0}C for 21 days. Peroxides values (PV) were monitored weekly for a total period of 4 weeks for each set of oil. Pictures were taken for each set of oil/shortening when they were treated initially. One-way ANOVA was performed in StatGraphics Centurion (XV) with treatment as independent variables and PV as dependent variable for the same storage data point. In our analysis, more emphasis was placed on statistical differences between treatments.

RESULTS

Oxidative stability index test (OSI):

Soybean Oil:

In soybean oil, approximately 5000 ppm of GT-FORT 101 SF was able to match the OSI hours of the TBHQ-based product EN-HANCE (Fig. 1). A linear dose response was observed up to the max dose level for GT-FORT. This demonstrates that the OSI vs. dose curve for GT-FORT 101 SF in soybean oil does not saturate and continues to be linear.

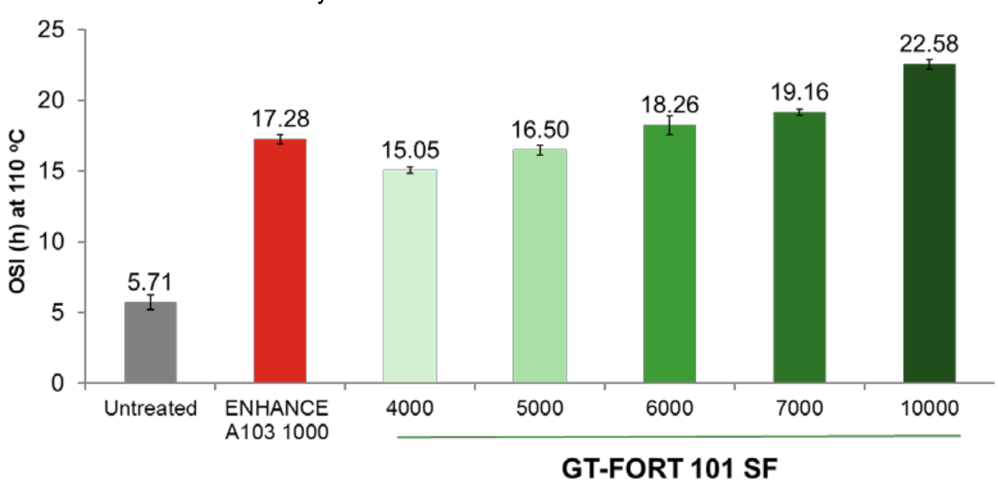

Figure 1. OSI hours of soybean oil at 110 ^{o}C. Error bars represented standard deviation of duplicates.

Canola Oil:

In canola oil, approximately 5000 ppm of GT-FORT 101 SF was able to match the OSI hours of the TBHQ-based product EN-HANCE (Fig. 2). Mixed tocopherols did not increase the OSI substantially. A linear dose response was observed up to the max dose level of GT-FORT. This demonstrates that the OSI vs. dose curve for GT-FORT 101 SF in canola does not saturate and continues to be linear.

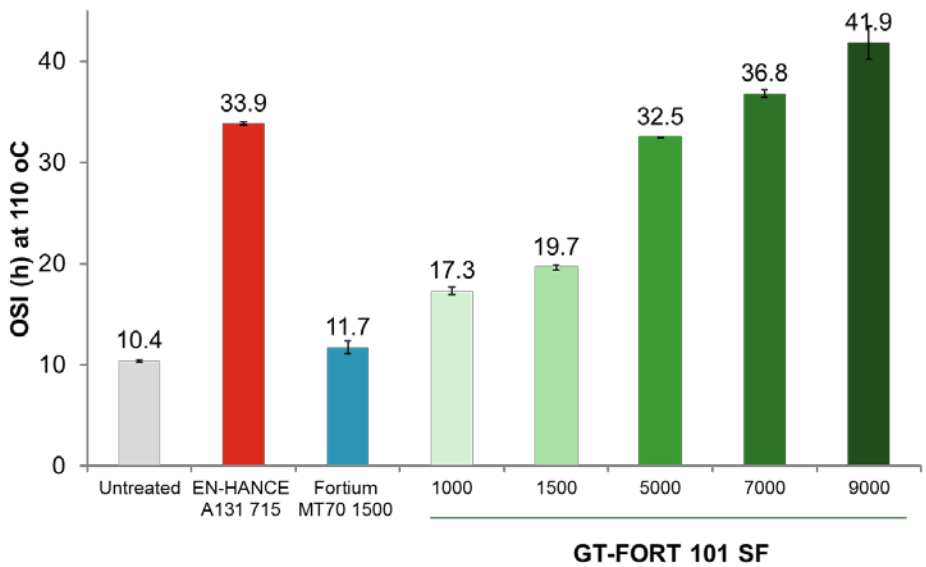

Figure 2. OSI hours of canola oil at 110 °C. Error bars represented standard deviation of duplicates.

Accelerated Shelf Life Test:

Soybean Oil:

The PV accumulation over storage time is plotted in Figure 3. Overall, GT-FORT 101 SF at 5000 and 6000 ppm performed similar to TBHQ in storage. At day 21, there was no statistical difference (P>0.05) between 6000 ppm and TBHQ whereas untreated and 5000 ppm were significantly (P<0.05) higher than TBHQ. At day 14, TBHQ was significantly (P<0.05) lower but numerically, both 5000 and 6000 ppm were within 1 PV unit of TBHQ. At days 3 and 7, there was no statistical difference between treatments whereas untreated was significantly (P<0.05) higher. Depending on the finished application and the desired shelf life, the treatment levels may be fine-tuned to achieve a closer match to TBHQ. Generally, in bulk oils, a PV of over 5-10 meq/kg fat is considered to be the threshold value for oxidation. Untreated sample was above the critical limit after 7 days of storage whereas the lowest treatment of GT-FORT, 5000 ppm, achieved this level in 21 days. This shows that a significant increase in shelf life can be achieved by treating the oil samples with GT-FORT 101 SF compared to untreated.

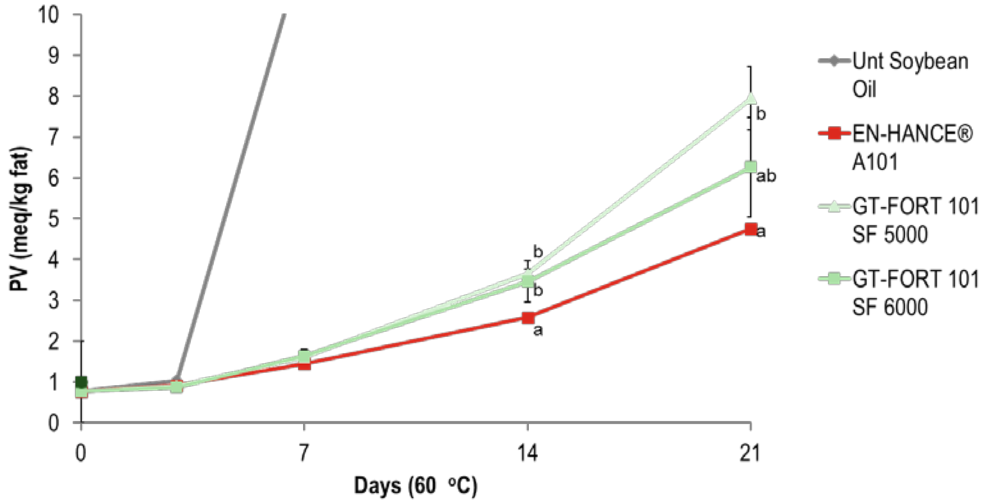

Figure 3. Peroxide value of soybean oil over 3 weeks of storage. Error bars represent standard deviation of duplicates.

Canola Oil:

The PV accumulation over storage time is plotted in Figure 4. Overall, GT-FORT 101 SF at 5000 and 6000 ppm performed similar to TBHQ in storage. At day 21, TBHQ was significantly ($P<0.05$) lower than both 5000 and 6000 ppm. At days 14, 7, and 4, there was no significant ($P>0.05$) difference between treatments. Generally in bulk oils, a PV of over 5-10 meq/kg fat is considered to the threshold value for oxidation. The untreated sample was above the critical limit after 5-7 days of storage whereas treated samples were below 10 meq/kg fat even after 21 days of storage. This shows that a significant increase in shelf life can be achieved by treating the oil samples with GT-FORT 101 SF compared to untreated.

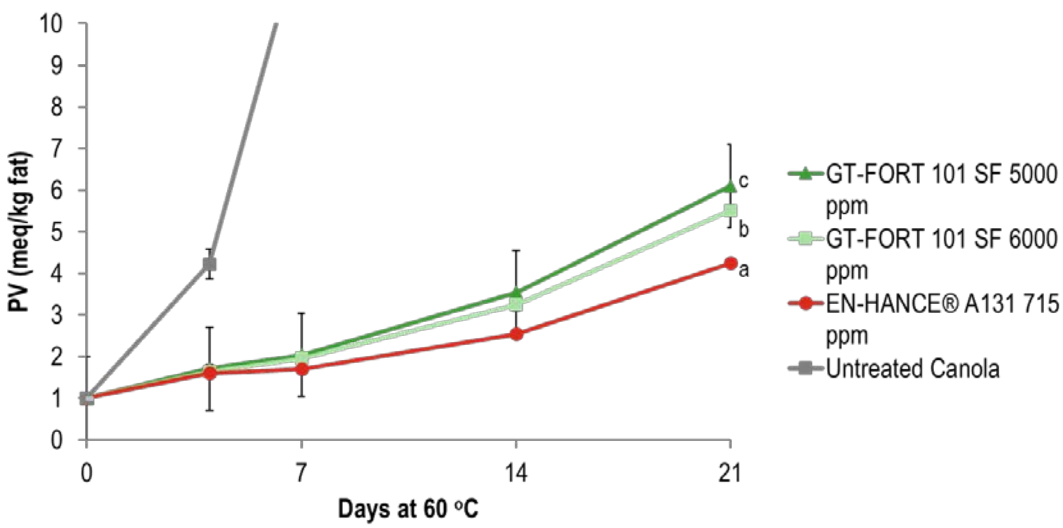

Figure 4. Peroxide value of canola oil over 3 weeks of storage. Error bars represent standard deviation of duplicates.

Pictures of Oil with Treatment:

Pictures of the oil with treatment taken at various levels showed minimal to no impact on color change in both soybean and canola oil (Fig 5 & 6). No change in odor of the treated oils was observed with the treatments.

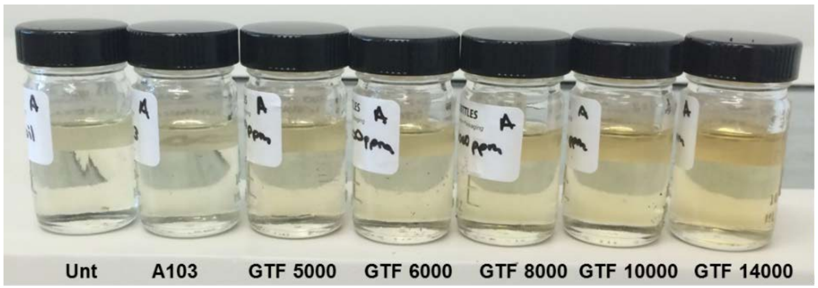

Figure 5: Appearance of treated soybean oil at various treatment levels

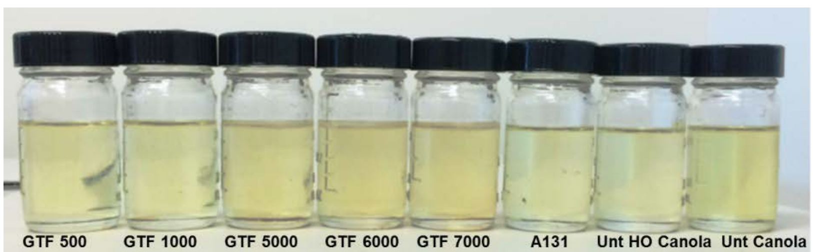

Figure 6: Appearance of treated canola oil at various treatment levels

CONCLUSION

OSGT is a plant extract with antioxidant properties that can help oil and food manufacturers achieve extended shelf life of their products and meet consumer demand for friendlier labels. It is highly effective in delaying lipid oxidation in bulk oils and finished foods where rancidity or flavor loss can limit shelf life. This study shows that OSGT-based product GT-FORT 101 SF can match the performance of TBHQ in soybean and canola oils as measured by OSI and accelerated shelf life testing. This study will provide formulators with proof of concept data to test GT-FORT 101 SF for TBHQ replacement in their finished formulations to achieve extended shelf life. In addition, the challenge of the incorporation of healthier lipids and reduction in saturated fat in certain food formulations can be further potentiated. Future studies will focus on finished food applications to validate the efficacy of OSGT.

REFERENCES

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