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RESEARCH ARTICLE

THE ETHIOPIAN CALENDAR'S UNUSUAL CALCULATIONS AND COMPARISON: DECIPHERING ITS EXCEPTIONALITY

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ABSTRACT

A calendar is a collection of days and dates humans use to guide their daily activities. The Ethiopian calendar system is significant in the socio-cultural lives of the Ethiopian people, who aspire to live peaceful lives. They believe the universe will be harmonious when people can coexist peacefully with God, one another, and the universe in a balanced way. With a comparison to the calendar system of another nation, this article seeks to establish the accuracy of the calculations performed with the Ethiopian calendar. The ancient astronomers definitively established the Ethiopian calendar in this investigation. Every four years is an extra day for Luka. Pagume only has six hours. The upshot is that there are now 366 days instead of 365 in a year. Leap years are the term for these years. Furthermore, the year will have 367 days in total after 600 years. The Ethiopian calendar system is vital to the social and cultural life of the Ethiopian population. It serves as a guide for duties such as keeping track of one's birthday, forecasting personality features, figuring out one's past, or analyzing the highs and lows of performing one's job. Furthermore, the findings showed that the new year, Meskerem 1 (September 11, 2043, G.C.), will start on Thursday in 2035 according to the Ethiopian calendar.

INTRODUCTION

The number of Days and years changed every time. The Ethiopian calendar is eight years behind the Gregorian calendar, and the 13th month has only 5-6 days. (Circa 2022) (Abera, 2006; Asrat, 1995). The Ethiopian month is 7, 8, 9, or 10 days behind, depending on how close the two calendar months are. The first 12 months have 30 days each; the word "Pagume" (13th) refers to the 13th month. The number of days is either 6 or 5, regardless of whether the year is a leap year. The exact date of Christ's birth is not known, but Ethiopian Christians believe that He was born 5,500 years ago, during the reign of King Herod. They argue that God was not involved in irrational acts and that the time was predictable. According to the Roman monk Dionasius, our Lord Jesus Christ was born 753 years after the founding of Rome Vaseilev, (1942); Dieter, (2005). The calculation began two centuries after him, but scientists who came to this conclusion many years later had already determined the Earth's beginning was off by at least four years. It was supported by a biblical reference in Matthew 2.1 and Luka 3:1-3, 22-23.

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As stated in Matthew 2:1, Jesus was born during the reign of King Herod Vaseilev, (1942); Dieter, (2005). Ethiopian Christians did not base their dates of birth on historical data. They used ages that are frequently mentioned in the Bible. They argue that God is not involved in irrational acts. He must have had a reason to mention these dates. Think about it, and you'll come to a surprising conclusion. Moreover, the birth of our Lord was predictable. The time was set. “When the time came, God sent forth his Son born of a woman,” writes Saint Paul in Galatians 4.4. There was talk of a waiting time which people would have to wait. Ethiopians believe this happened 5,500 years ago. Time is a mysterious dimension. Ancient Ethiopian astronomers calculated the beginning and end times of the universe, and the Ethiopian Orthodox Church used a mathematical method to define moveable holidays and fasting. Ancient Ethiopian astronomers calculated the beginning and end times of the universe. It was found in the book called Bahre Hasab (Yared, 2004; Bekerie, 2008; Hope, 2019; Louri, 2012). It consists of the words 'bahre' and 'hasab'. Scholars of the Orthodox Tewahdo Church refer to the breadth and profundity of thoughts as "oceans of thought" (Bahre Hasab, Amharic, 1-3, 11). Biblical scriptures lend support to the idea that time can be quantitatively expressed mathematically (Abera, 2006; Asrat, 1995; Yared, 2004).The notion that time can be quantified mathematically is supported by biblical texts (Abera, 2006; Asrat, 1995; Yared, 2004). The Dead Sea

Scrolls (DSS) calendar is found in Ethiopia, halfway between Babylonia and Ethiopia. It is based on late Jewish calendric traditions that were available in Greek throughout the Hellenistic epoch but have since been permanently lost in this language. The Ethiopian translation of the Astronomical Book (AB), published in Enoch, is the most important Ethiopian document, followed by the Book of Jubilees (Lurie, 2010; Neugebauer, 1981). Furthermore, many small astronomical treatises, largely written in Geez but following some Jewish astronomical traditions contemporaneous with the DSS, are exceedingly noteworthy(Louri, 2010; Neugebauer, 1981); Rodas and Getnet, (2019). Ethiopic kentros is the name of each of these 30 parts, just as Ethiopic kekros is the name of each of the corresponding unity's 60 parts. A calendar organizes days, months, and years to measure, record, and keep time for administrative, social, religious, or commercial purposes (Simegne,2002). The Geez calendar, used by Ethiopia and Eritrea, is a system of organizing days, months, and years to measure, record, and keep time for administrative, social, religious, or commercial purposes (Abera, 2006; Asrat, 1995; Yared,2004). As a result, when the new moon first appears, a widely celebrated festival is held on a different day than the rest of the world. The Sumerian calendar was based on the observation of the new moon, and the ancient Egyptian calendar was based on the solar year. The Ethiopian calendar is based on the Geez language and is said to have originated from the Coptic customs of Alexandria. A year was divided into 12 months, and one month which has 5 days (Simegne, 2002; Tafesse, 2008). On the first day of the year, the Nile's highest point entering Memphis coincides with the helical ascent of Sirius. The unused years of the disappearing Egyptians began with Meskerem 1. According to the unused year of the Ethiopian calendar, this day marks the end of Noah's ascension. Ethiopians use a Coptic calendar similar to that of ancient Egypt. The Ethiopian calendar is said to have originated from the Coptic customs of Alexandria. In addition, the name of the Egyptian steward, Abu Shakir, is recorded in the Bahre hasab (Bekeri, 2008).The calendar days and months are derived from the Guise language. Ancient Ethiopian astronomers contributed to the uniqueness of this country with their knowledge and language. The purpose of this research is to demonstrate the uniqueness of Ethiopian calendar computations and comparison with other calendars

The Gregorian Calendra: The Julian calendar was updated by Pope Gregory XIII in 1592 and became known as the Gregorian calendar. Once started, it gradually spread to Italy, Portugal, Spain, and Catholic countries in Germany. The German Protestant states adopted it in 1699; Britain and its colonies, including the United Nations, did the same in 1752; Sweden did the same in 1753; Japan did so in 1873; and China, the Soviet Union, and Greece did so in the early 1800s. This is now the most widely used calendar system in the world. The 2020s, for those following the Gregorian calendar, will soon begin. The Gregorian calendar is the world's most widely used timekeeping system, but it's worth remembering that there are other timekeeping systems as we get closer to this milestone.

Bali's Pawukon Calendar: The Pawukon calendar is one of two calendars used on the Indonesian island of Bali. The length of a year is two hundred and ten days. It is divided into six months of thirty-five days Nachum and Edward, (2014). This number is associated with the rice production cycle. Additionally, it is quite complicated and can be difficult for outsiders to understand. The first day of the year coincides with the beginning of each of ten separate weeks, consisting of one, two, three, four, five, six, seven, eight, nine, and ten days. Thus, the first day of the new ten-day week would begin on the eleventh day of the year, followed by the nine-day week on the second day, the eight-day week on the third day, and so on. Additionally, days tend to repeat during these weeks because two hundred and ten is not divisible by four, eight, or nine. Additionally, the days in the Pawukon calendar are not necessarily in the same order as the Gregorian calendar, in which Tuesday always follows Monday. While the Pawukon calendar is used to determine some holidays in Bali, some also use the lunar calendar. The calendar has twelve months, each of 29 to 30 days, which is comparable to the Gregorian calendarNachum and Edward, (2014).

Chinese Calendar: The traditional Chinese calendar is still used to determine the dates of important holidays such as the Chinese Lantern Festival, although modern China uses the Gregorian calendar. It is also a useful tool for choosing auspicious dates for weddings, funerals, house moves, and business openings. The Chinese calendar, which has twelve months, each with twenty-nine or thirty days, begins on the first day of the new moon and is essentially lunar. In the Chinese calendar, a leap month was added if it was needed, instead of days. Animal names or numbers also correlate with specific times of the day, and years in the zodiac cycle can be used to refer to each month. Animal names or numbers also correlate with specific times of the day, and years in the zodiac cycle can be used to refer to each month. The animals are rats, cows, tigers, rabbits, dragons, snakes, horses, sheep, monkeys, chickens, dogs, and pigs in this series of appearances. Far East countries like Korea, Vietnam, and the Ryukyu Islands are using the Chinese sieve.

Hebrew Calendar: The Hebrew calendar is lunar, starting each month with the new moon, just like the Chinese calendar. Because there are about 12.4 lunar months in a solar year, the 12-month lunar calendar is a bit short and the 13-month calendar is a bit long. This is a problem that only occurs with the lunar calendar. Therefore, the Jewish month of Nissan, which is said to fall in spring, will gradually change to winter, autumn, and summer if a 12-month lunar calendar is used. This is important because most festivals and holidays are always associated with the seasons and when they take place. The fixed Jewish calendar of Hillel II, repeating the month of Adar every third, sixth, eighth, eleventh, fourteenth, seventeenth, and nineteenth year in a nineteen-year cycle, provided a solution to the problem of this dilemma in the fourth century. Today, the Jewish New Year falls in the month of Tishri, while Passover always occurs in the month of Nissan. Interestingly, even though a large number of Jews outside Israel follow the Gregorian calendar, they rarely use the abbreviations A.D. and B.C. Because the Jews do not recognize Jesus as Lord, they use acronyms for our times (common or Christian times) and BC. (B.C). AD means “year of our Lord”.

Islamic, Muslim, or Hijra: The Islamic calendar is lunar. It does not use months or leap days to adjust for changes in the length of the solar year. Therefore, the months indicated no longer belong to the same season. They have the same seasonal time after receding through the calendar year and the last 32 and a half years. The journey of the Muslim prophet Muhammad from Mecca to Medina, known as the Hegira, is the basis for the starting date of the calendar. The Gregorian

calendar is used for civil purposes and the Islamic calendar is mainly used for religious purposes in Muslim countries.

Hijiri (Persian or Solar) Calendar: One of the most accurate calendar systems in the world is the Persian calendar, according to some reports. It dates to the time of Muhammad's Hegira in 622 CE, like the Islamic calendar, although it is otherwise very different. Instead of using a lunar calendar, this calendar uses solar energy, with the Iranian year starting at midnight on the spring equinox. The twelve months are numbered, the first six have thirty-one days, the second five have thirty days and the last month, Esfand, has thirty days or twenty-nine days in a leap year. The Persian calendar determines leap years based on the number of days between the two vernal equinoxes, unlike the Gregorian calendar which uses a series of mathematical criteria to determine when a leap year falls. Currently, Iran and Afghanistan officially use this calendar.

MATERIAL AND METHODOLOGY

Living in Ethiopia means you are truly behind the times. In the Ethiopian calendar, the new year falls on September 11 according to the Gregorian calendar, seven years later according to various calculations of the date of the announcement of the birth of Jesus Christ. This brings us to the early hours of Ethiopia time in 2012. While it seems like tourists in Ethiopia have no trouble making appointments, things get even more complicated. It is important to convert times in addition to dates. This is accurate because most Ethiopians do not use the pre-meridian (am) and post-meridian (pm) timekeeping systems to keep track of time. Ethiopia's location near the equator means the number of daylight hours is fairly constant all year round. The 12-hour clock forms the basis of local time, with two cycles: one from dawn to dusk and one from dusk to dawn. As a result, 7 a.m. East African time switches to the local time of the day, and Ethiopians reset their clocks at 7 p.m. East Africa time, it became one o'clock in the evening.

Source of data: For analysis and incorporation with the distinctive Ethiopian calendar calculation, variousbooks from the Ethiopian Orthodox Church were used as the data source. Additionally, the priest is used to gather the data.

Method of analysis: To show the uniqueness of the Ethiopian calendar, the author used Phyton programming languages to compute the dates. The computations of the dates for the next five years were also analyzed using Excel.

Important Terms: Ethiopia has an ancient calendar that dates from 5493 B.C. It has been 2015 years since Jesus was born, and we are within the year 7515. These are alluded to as Amete Alem in Amharic, or "the time of the world". The world dates from 5493 B.C.The important points for calculating the calendar are the following:

- The Ethiopian years have four-year cycles. The years are named after the evangelists; Matthew, Mark, Luke, and John.
- Amete Alem is the combined number of years before and after the birth of Jesus.

$$AM = YBC + YAC \quad (1)$$

where AM is Amete Alem, YBC is the year before the birth of Jesus Christ, and YAC is the year after his birth. The name of the Evangelist was used for the name of the year. The year is divided into four, and the remainder of Amete Alem is:

1, the year of Mathewos(Matthew)
2, the year of Markos(Mark)
3, the year of Lukas(Luke)
0, the year of Yohannes(John)

- Each year has four seasons, autumn(fall), winter, spring, and summer.
- A week of seven days.
- A time frame known as Kekros. **Kekros is 1/60th of a day**.
- A Kekros is 60 Kalet,
- A Kalet is 60 Salesit,
- A Salesit is 60 Rabit,
- A Rabit is 60 Hamesit, and
- A Hamesit is 60 Sadusit

Where Kekros, Kalet, Salesit, Rabit, Hamesit, and Sadusit are used to measure standard measurements of time: hours, minutes, and seconds.

RESULTS AND DISCUSSION

The period between successive sun crossings across the vernal equinox is known as the tropical year, or period of the seasons. The tropical year decreases slowly due to perturbations in Earth's motion caused by the other planets' gravitational pull and precession acceleration. This can be observed by comparing the length of the tropical year at the end of the 19th century (365.242196 d) with that of the 20th century (365.242190 d). The close match between the length of the tropical year and the average calendar day of 365.2425 days in the Gregory calendar accounts for its accuracy. Similarly, there are 28 to 31 calendar days in a month; 30.437 is the average. The average length of the synodic month, which is the period between new moons, is 29.531 days. According to the solar calendar, Earth revolves around the sun for 365 days, 6 hours, and 9 minutes, with an extra day added every fourth year. The star's orbital speed ranges from 29.29 to 30.29 km/s. The Earth's orbit around the Sun is shaped like an ellipse, and the distance between the Earth and the Sun varies by 3 percent during one revolution as shown in Figure 1.The Earth is at its closest distance to the Sun at perihelion, which occurs on January 3. It is farther from the sun at Aphelion and July 4. The distance between the Sun and Earth varies by 3 percent during one revolution. Since the path is an elliptical orbit shaped like a circle. For this purpose, we can regard the orbit as circular.

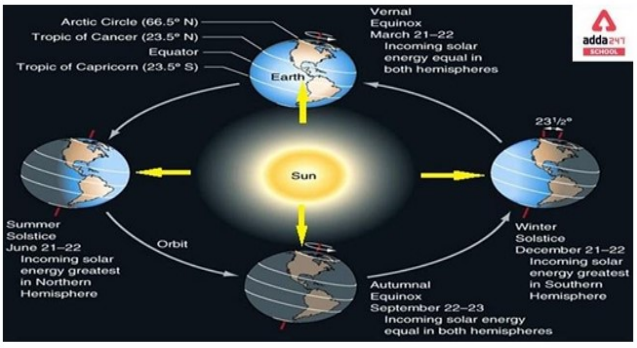

Figure 1. The Earth revolves around the Sun (adopted from www.adda247.com)

Traditional Ethiopian astronomical notions, particularly Kekros and Kentros, are potential candidates for Babylonian heritage. They are equivalent to 1/60 and 1/30 of a time interval, respectively (Louri, 2010; Neugebauer, 1981; Simegne, 2004). Each of the sixty parts of the circle was given the name Ethiopic Kekros. Ancient Ethiopian astronomers calculated that one day is equal to 60 Kekros, 52 Kalet, and 31 Salesit. A month is equivalent to 30 days. Therefore, one month is equivalent to:

30 days = 60× 30 Kekros = 1800 Kekros

Similarly, one year is equal to 12 months. According to ancient Ethiopian counting, there are 360 days in a year, which is equivalent to 21,600 Kekros.
This is equivalent to 360 days. There are also additional time values for counting time in a day, which equal 52 Kalets in a day. Therefore, the total Kalet value in a year is

$$TK = 52\frac{\text{Kalet}}{\text{day}} \times 30\frac{\text{day}}{\text{month}} \times 12\text{month} = 18{,}720\ \text{Kalet} \qquad (2)$$

where *TK* is the total Kalet time in a year. Since 1 Kekros = 60 Kalet, the total number of *TK* in Kekros is 312 Kekros. The total number of remaining (*TNRD*) days in a year is given by

$$TNRD = \frac{TK}{60\text{Kalet/Kekros}} = \frac{18.720\ \text{Kalet}}{60\ \text{Kalet/Kekros}} = 312\ \text{Kekros} \qquad (3)$$

The total number of remaining days is given by dividing *TNRD* by a day. Since a day is equivalent to 60 Kekros. Therefore, TNRD is 312/60 = 5.2 days. Pagume will take 5 days. Therefore, the total number of days in a year is 360 + 5 = 365.
According to ancient Ethiopian astronomers, one day is equal to 60 Kekros, 52 Kalet, and 31 Salesit Abera, 2006; Asrat, 1995; Yared, 2004;Tafesse, 2008; Taddesse, 2008; Ethiopian, 2010; Ethiopian, 1996). The remaining number 31, Salesit, was not taken into account. Let us consider this value by finding the number of days in a year. Every day, there are 31 Salesit. In a month, we will have 930 Salesit. In a year, we will have 3 Kekros and 6 Kalet. The total number of Kekros is 12 + 3 = 15 Kekros and 6 Kalet. According to the Ethiopian Orthodox Church, Amete Alem is divided by the

year of Yohannes (John)	15 Kekros,
year of Mathewos (Matthew)	15 Kekros,
year of Markos (Mark)	15 Kekros, and
year of Lukas (Luke)	15 Kekros.

After every four years in Lukas, we have one additional day. Pagume will be six days. Therefore, the total number of days in a year will be 365 + 1 = 366 days. This is called a leap year. In the Ethiopian calendar leap, years come every four years. After 600 years, the number of days in a year will increase by 1 Kekros, which will equal 1 day,and one year will be 367 days (Abera, 2006; Asrat, 1995; Yared, 2004;Bekerie, 2008; Hope, 2019; Louri, 2010). How will this occur? From the above calculation, we have the remaining 6 kalets every year. The number of kalets after 10 years will be 60 kalet, which is 1 kekros. Similarly, the number ofkekros after 600 years will be 60 kekros, which is one day. Pagume will be 7 days old after 600 years. Therefore, after 600 years, the number of days in a year will be 367 days. Ethiopia has a calendar with 13 months, and each of the 12 months has 30 days, while the 13th month, called Pagume, has five days, which becomes six in each leap year or seven days after 600 days (Abera, 2006; Asrat, 1995; Yared, 2004). Ethiopian Orthodox Church beliefs say that God created the earth 5500 years before the birth of Our Lord and Savior Eyesus Kristos and that it has been 2015 years since his birth.This timeline places us in the year 7515 (5500 + 2015) of the eighth millennium.

These are known as Amete Alem, or "The Years from Creation`s Beginning. Amete Alem is the sum of the number of years after the birth of Our Lord and Savior, Eyesus Kristos. The year after the birth of Christ is 5500. According to Ethiopian Orthodox Church beliefs, the creation begins in the fifth chapter of Genesis 5:3. Ethiopians began counting years following Christ's birth, and the total number of years from Adam to Abraham's exile is 4990. From Abraham to the Exodus, it was 75 years; from the Exodus to Samuel, it was 513 years; from Saul to Solomon, it was 120 years; from Solomon to the Exodus, it was 394 years; and 70 years in exile. Ethiopians began counting years from birth. Their combined age was 1527 years. That period totals 4990 years. The calculation in this case is based on a passage from the Book of Daniel. (Dan9:24-25).

This is the beginning of his seventh year of reign as Persian King of Altaxi (Ezra 7: 6-9). It was the 76th year of the Persian kingdom and included the first seven "sevens". As a result, 510 years equals his 76 years plus 434 (=62 x 7). We finally arrived at our destination. That amount would add up over the years. 5500(4990+510) is desirable. God's Timeline for Adam's Arrival on Earth. The Ethiopian New Year starts when the heavy rainfall starts to cease and the sky is blue. The land is green and covered by golden flowers, known in the Amharic language as "Adey Ababa(Bekerie, 2008; Hope, 2019; Simegne, 2002; Simegne, 2004). The New Year in Ethiopia is celebrated with new hope, and the people are making special preparations. The Ethiopian New Year varies from day to day. Its calculation can be done in the following manner. To find out the day when the Ethiopian New Year starts, find out Amete Alem and Metene Rabiet (MR) and divided by 7 (Simegne, 2004). The remainder is given the name Tinte Qemer (TQ), which is the first day that the New Year (NY) begins.

If Tinte Qemer is:

0, the new year starts on Monday.
1, the new year starts on Tuesday.
2, the new year starts on Wednesday.
3, the new year starts on Thursday.
4, the new year starts on Friday.
5, the new year starts on Saturday.
6, the new year starts on Sunday.

$$TQ = \frac{AM+MR}{7} \qquad (4)$$

where *AM = 5500+ NY, MR = AM/4*, and it is divided by 7 because a week has 7 days. For instance, in 2015 E.C., the new day is

$$AM = 5500 + 2015 = 7515 \qquad (5)$$

The quotient without the remainder is calledMetene Rabiet (*MR*) and is given by

$MR = \frac{7515}{4} = 1878$ using a quotient division. The remainder of this division is 3. The Evangelist of the Year (Wengelawi) is named Markos.

Tinte Qemer (TQ), or the first day of the New Year, can be determined using the following equation:

$$TQ = \frac{AM+MR}{7} = \frac{7515+1878}{7} \quad (6)$$

$TQ = 1341$ remaining 6 which is Tinte Qemer

Thus, the year 2015 starts on Sunday (Meskerem 1) (Ethiopian, 2010, Ethiopia, 1996;htpps://www. wikipedia.org). Similarly, the first New Year's Day of 2016 starts on Tuesday (Meskerem 1). The new years for the next10 years are shown in Table 1. The results show that the year 2035 starts on Thursday (Meskerem 1).

Table 1. The new year starts for the next coming 16 years

Years	Remainder	New Year's starts at
2016	1	Tuesday (Meskerem1)
2017	2	Wednesday(Meskerem1)
2018	3	Thursday (Meskerem 1)
2019	4	Friday (Meskerem 1)
2020	6	Sunday (Meskerem 1)
2021	0	Monday (Meskerem 1)
2022	1	Tuesday (Mekerem1)
2023	2	Wednesday (Mekerem1)
2024	4	Friday (Meskerem 1)
2025	5	Saturday (Meskerem 1)
2026	6	Sunday (Meskerem 1)
2027	0	Monday (Meskerem 1)
2028	2	Wednesday (Mekerem1)
2029	3	Thursday (Meskerem 1)
2030	4	Friday (Meskerem 1)
2035	3	Thursday (Meskerem 1)

The Gregorian calendar approximates the tropical year as 365+97/400 days, but the Eastern Orthodox calendar uses 365+218/900 days, which is more accurate than the official Gregorian number of 365.2425 days. Furthermore, the Ethiopian calendar has 100 leap years every 400 years, while the Gregorian has 97 (htpps://www.wikipedia.org; htpps://www.keraneyo-medhanealem.com).

Yet, in the Eastern Orthodox system, a century year is a leap year only if the division of the century number by 900 leaves a remainder of 200 or 600 with 365+218/900 days =365.242222 days, which is certainly more accurate than the official Gregorian number of 365.2425 days. Furthermore, due to the gravitational dynamics of the Sun-Earth-Moon system, the length of the tropical year is not constant. In the Ethiopian calendar, leap years come every four years. The Julian year is equal in length to the Coptic or Ethiopian year. In the Gregorian calendar, every year that is exactly divisible by 4 is a leap year, except for years that are exactly divisible by 100; these centurial years are leap years only if they are exactly divisible by 400. Originating on the Indonesian island of Bali, the Pawcon calendar is a 210-day calendar with Hindu religious roots. Each week has days, for a total of 30 weeks (6 months, 35 days). Ten different weeks of 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10 days simultaneously make up the calendar. The entire calendar repeats every 210 days of his life, but this 210-day "year" of his has no numerical value. Only sub-cycles of length 5, 6, and 7 form a calendar. Repetitions and other complexities adjust other sub-cycles Nachum and Edward, (2014). In the Hebrew calendar, there are 235 lunar months of the 19-year cycle prescribed to have 29 days, 12 hours, and 793 halaqim. Astronomical calculations show that the true rate is 365.2422 days per year. The hour is divided into1080 units, or halaqim, one halaqim equals 3 1/3 seconds.The following abbreviations are used: mn=minute, sc=second, hr=hour, hq=halaqim, and dy=day.

At this time there are 19 solar years in exactly 235 lunar months.Twelve common years (12 months) and seven leap years (13 months) form a cycle.The 3rd, 6th, 8th, 11th, 14th, 17th, and 19thyears of leap years.

1month = 29d, 12hr, 44mn, 10/3sc

In normal years, 12 months = 29*12d, 12*12 hr, +33mn*12, 12*10/3 =(354d, 8hr, 48mn, 40s)

In the Jewish calendar the year is given by the following equation

$$Y_{J=}Lm \times \left(\frac{d+hr+hq}{19}\right) \quad (7)$$

Where $Lm$is the lunar month which is 235, $d$is days, hr is the hours, and 12 hr, and hq is the halaqim. Each lunar month is defined as being 29 days, 12 hours, and 793 halaqim (10/3 sc).Therefore, the average number of days in a year is according to Eq. 7 is

$$Y_{J=}Lm \times \left(\frac{d+hr+hq}{19}\right) = 235 \times \left(\frac{29\text{days} + 12\text{hr} + 10/3\text{s}}{19}\right) = 365.2468 \text{ days}$$

In Gregorian Calendar the number of days in one calendar year is determined by the following equation.

$$y_d = d + \left(\frac{NoEx-3}{y_c}\right) \quad (8)$$

Where y_d is the number of days in one calendar year, $NoEx$ number of no extra days in yyears100, 200, and 300, and y_c is a year cycle and equal to 400. According to Eq. 8, the number of days in one calendar year in Gregorian is

$$y_d = d + \left(\frac{NoEx-3}{y_c}\right) = 365 \text{ days} + \frac{100-3}{400}\text{days} = 365.2425 \text{ days}$$

The average Jewish year exceeds the average Gregorian year by .0042 days. Therefore, the Jewish calendar will creep one day every 1/.0042 years which calculates to 238 years. The twelve months that make up the Islamic calendar start roughly with the new moon. There are either 29 or 30 days in a month. The first day of the next month is the day after if, on the evening of day 29, the Crescent Moon is visible soon after sunset. If no sighting is reported, the current month's thirty days are added, and the first day of the next month is then observed.

$$y = d \times m \quad (9)$$

Where y is the number of days in the year, d is the number of days in a month, and m is the number of months in a year. Accordingly, there are twelve lunar months in the Islamic tabular calendar, and the number of days in the month is 29.530589. The number of days in one lunar year is

$$y = d \times m = 12 \times 29.530589 = 354.367068$$

We obtain a common year of 29.5 × 12 = 354 days if we assume it is 29.5 days and the lunar civil months are adjusted to have 30 and 29 days alternately. This is less than 29.530589 × 12 = 354.367068 days by 0.367068Hijira, (2009). The Islamic year has either 354 or 355 days. It is based on a 30-year cycle that consists of 19 years with 354 days and 11 years with 355 days. In normal years, the last month has 29 days, and in leap years it has 30 days. The first six months have 31 days, the next 5 months have 30 days, and so on. The Hijri Solar Calendar is solar and one of many Iranian calendars Debbie, (2020). It begins on the March equinox, determined by astronomical calculation of the meridian according to Iran Standard Time (52.5°E, UTC+03: 30), and has a year of 365- or 366 days Shaikh, (2001). Ethiopian time is 3 hours ahead of GMT (Greenwich Mean Time) and is equally divided into day and night, each consisting of 12 hours from sunrise to sunset and vice-versa. Ethiopian time is separated into day and night, with each lasting 12 hours from sunrise to sunset, and is three hours ahead of Greenwich Mean Time (GMT). Due to the diverse cultural backgrounds of Ethiopians, each nationality has its calendar. We simply pay attention to Ethiopia's national calendar for this study. The names of the months in Ethiopian and Gregorian in the year are shown in Table 2.

Table 2. The name of the Ethiopian and Gregorian month in the year

Ethiopian Month	Gregorian Month	Equivalent Gregorian month
Meskerem (Month 1)	September (Month (9)	September 11-October 10 (begins September 12, during leap years)
Tikimit (Month 2)	October (Month 10)	October 11- November 9
Hidar (Month 3)	November (Month 11)	November 10- December 9
Tahasas (Month 4)	December (Month 12)	December 10- January 8
Tir (Month 5)	January (Month 1)	January 8 – February 7
Yekatit (Month 6)	February (Month 2)	February 8- March 9
Megabit (Month 7)	March (Month 3)	March 10- April 8
Miyazia (Month 8)	April (Month 4)	April 9- May 8
Ginbot (Month 9)	May (Month 5)	May 9- June 7
Sene (Month 10)	June (Month 6)	June 8- July 7
Hamle (Month 11)	July (Month 7)	July 8- August 6
Nehasse (Month 12)	August (Month 8)	August 7 – September 5
Pagume (Month 13)	September (6- 10) ends September 11, during leap years	

CONCLUSION

Ethiopia has a very ancient calendar system different from the Gregorian one. Since there is a difference between the Gregorian and Ethiopian calendar systems in terms of dates, months, and years there should be a calendar system that provides both calendar systems together.The results show that the Ethiopian calendar has very similar features to the Gregorian calendar approximating the tropical year as 365+97/400 days, but the Eastern Orthodox calendar uses 365+218/900 days, which is more accurate than the official Gregorian number of 365.2425 days. Furthermore, the Ethiopian calendar has 100 leap years every 400 years. Moreover, the last month at the end of the year varies from 5-6 days. For a leap year, the number of days would be 6 and if it's not a leap year, it becomes 5. After 600 years, a year in the Ethiopian calendar will be 367 days. Muslims utilize the Islamic calendar, commonly referred to as the Hijri or Lunar calendar, throughout the world. It is based on the lunar cycle, with the sighting of the new moon marking the start of each month. With 354 or 355 days, the Islamic year is shorter than the Gregorian year.

In Jewish religious observances, the calendar known as Israel or Hebrew is utilized. To correspond with solar years, the calendar is lunisolar, mixing monthly lunar periods with sporadic intercalary months. The Israeli calendar consists of twelve or thirteen months and seven leap years spread across 19 years.The Jewish Month and the Muslim Month differ by 1 halaqim or 3 1/3 seconds Pope Gregory XIII established the Gregorian calendar, which is still in use around the world, in 1582. This solar calendar has 366 days in leap years and 365 days in regular years. Except for years that are divisible by 100 but not by 400, leap years happen every four years. Iran and Afghanistan use the Iranian, or Persian, calendar, which is a solar calendar. It has twelve months and is based on the vernal equinox. The spring equinox, which falls on March 20 or 21, marks the start of the year. In China and other East Asian nations, the lunar or agricultural calendar also referred to as the Chinese calendar, is in use. It incorporates solar corrections with lunar months. Following the winter solstice, the second new moon coincides with the Chinese New Year. Chinese zodiac animals are linked to each year (e.g., Year of the Rat, Year of the Ox). This is why the year calculation of the Ethiopian calendar is unique. In addition, the Ethiopian calendar reflects the rich cultural heritage of Ethiopia and its connection to religious events. In summary, the Ethiopian calendar's exceptional features, leap days, and distinct calculations make it a fascinating system that has endured for centuries. In conclusion, it is fascinating to study how different calendars reflect distinct historical, religious, and cultural settings. In addition, the historical background and remarkable computations of the Ethiopian calendar make it a fascinating subject of study.

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